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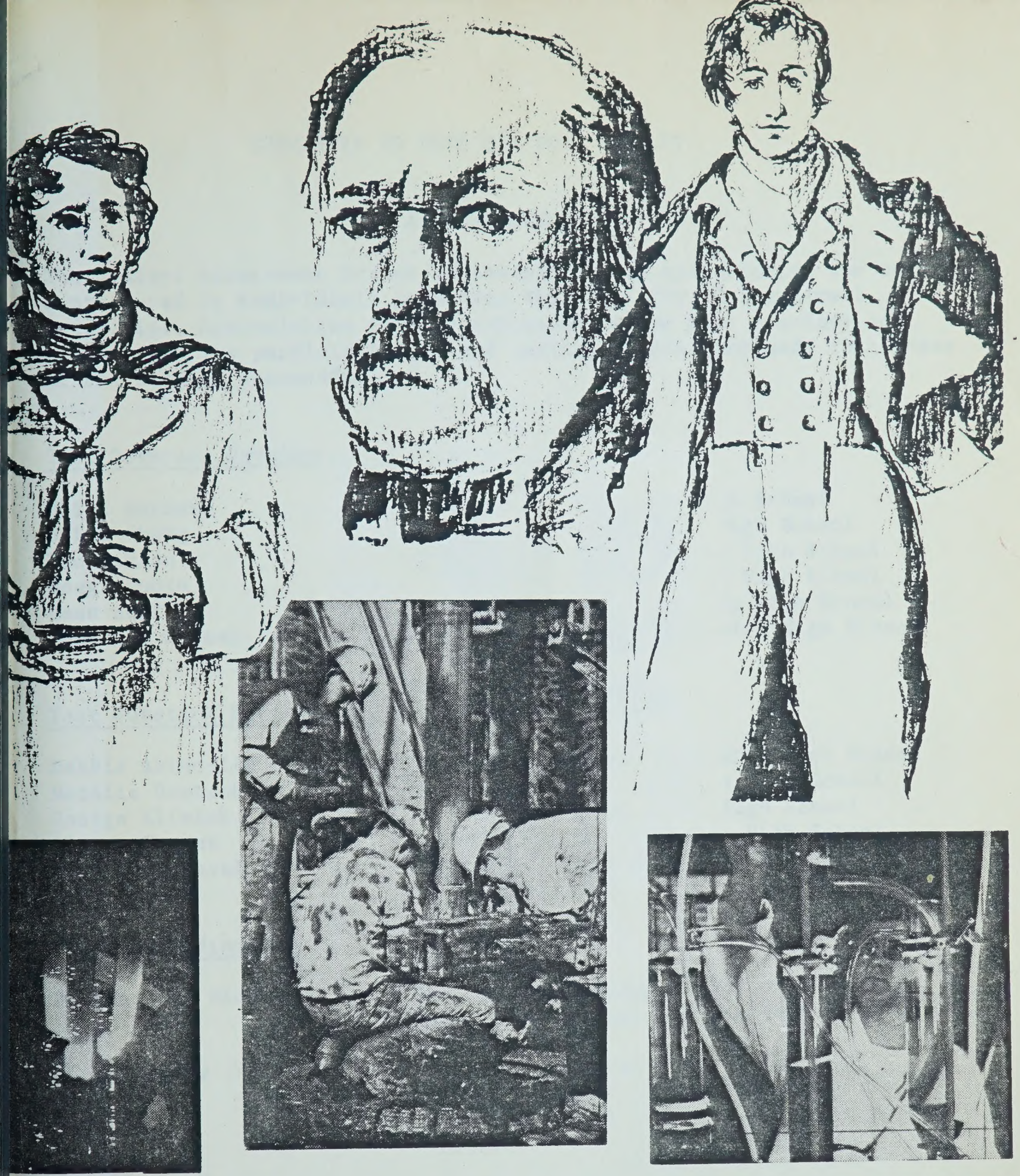

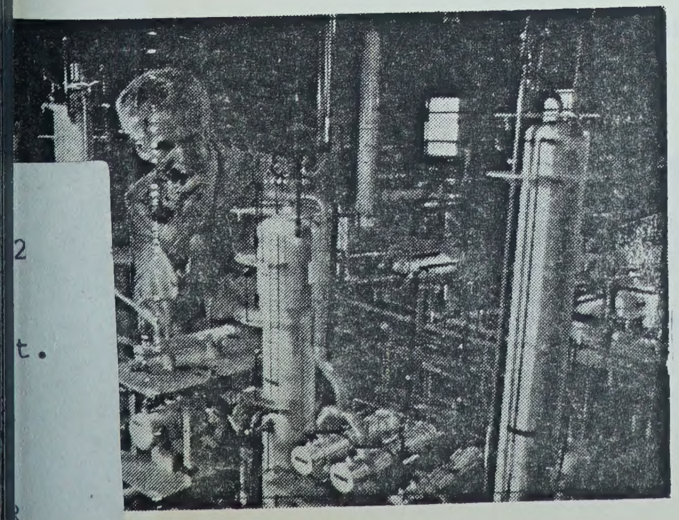

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CHEMISTRY 20 TEST QUESTION BOOKLET

ACKNOWLEDGEMENTS

The Student Assessment Branch acknowledges with appreciation the work contributed by individuals preparing the Chemistry 20 assessment materials. Appreciation is also expressed to the many teachers and students in the participating field testing schools who made that phase of the project successful.

Test Question Development Committee, 1979

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Introduction

The test questions on the following pages are based on the Chemistry 20 program objectives as developed for Alchem 20, 1978. The objectives listed in the Table of Contents are those found in the Alchem program. Questions based on these objectives were developed in 1979. In addition, those questions which were developed in 1975 were updated. Both sets were field tested during the 1979-81 schools year in Edmonton public high schools. A review was completed during the summer, 1981. It is intended that these assessment materials serve as useful assessment aids to Chemistry 20 teachers as they carry on their science evaluation program.

Test Question Organization

The test questions are organized in the booklet according to unit and objective headings (Table of Contents). Find the concept area(s) you are interested in testing and select the appropriate questions. For each question, in the left-hand margin, two or three figures are listed. These figures indicate:

1. the call number for the question,
2. the proportion of students who answered the question correctly during field testing, and
3. the correct answer choice.

The call number for the question is composed of three or four parts. First the unit is indicated (G, H, I, or J). Second, the objective being assessed within that unit (the objective number as given in the Table of Contents) is given. Third, the question number within that objective is listed. An example is H3.10 which means the tenth question on objective 3 in Unit H. These three pieces of information give every question or piece of textual information a unique call number within the question booklet.

In addition to these three pieces of information, some further descriptors are added when necessary in the fourth part of the call number. An asterisk (*) means the objective listed immediately under the main call number is also assessed either in that particular question or in one of the questions found in that question set. An example is:

H7.4* -	Question
H2*	or
	Textual Information

This means the fourth question in the objective 7 section is on both objectives 7 and 2 from Unit H. This fourth part may also include two additional pieces of information. A capital "D" may be there if a hand-drawn diagram or symbol is included in the question or piece of textual information. A capital "T" may be there if the text is required information for subsequent questions or is one of those subsequent questions which is dependent on a piece of text.

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The difficulty rating for most questions is given next. This proportion, which tells the number of students who had success with the question, is a three digit number based on 1979-80 data. Questions that were revised extensively or added to the booklet during review do not have a difficulty rating.

Preparation of Classroom Tests

Classroom tests may be prepared the traditional way or their master may be requested from Student Assessment. Information about this procedure is available from Mrs. S. Michaels, Student Assessment.

Scoring and Analysis of Classroom Tests, REVISED 1977

If multiple-choice tests are submitted for scoring and/or analysis, they should consist of a minimum of 30 test questions and have been administered to 75 or more students. For schools (teachers) desiring only scoring, key sheet and class sheets should be completed as indicated in the NEW "Test-Scoring Service Information Booklet, Version 2, September, 1976." Then the answer sheets (brown or green), key sheet and class sheets should be sent directly to the computer data processing centre (ISB). At ISB, a test scoring printout will be prepared for each test and directly returned to the school. For schools desiring both scoring and item analysis of student data on a particular test, the teacher concerned should contact Mrs. A. Mulgrew, Student Assessment. Arrangements for providing this information for the particular test will be made.

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UNIT G - CHEMICAL BONDING

Objective 1: Understand why chemical bonding occurs

Ar will not form a chemical bond with Cl atoms because

A. Cl exists naturally as Cl_2
B. Cl has electrons in all four orbitals
C. Ar already has 2 electrons in each valence orbital
D. Ar is too nonmetallic

The reason why all chemical bonds are formed is to

A. fill the inner orbitals of atoms with electrons
B. make available more bonding electrons
C. cause a transfer of electrons
D. produce a more stable electron distribution

Chemical bonds form for all of the following reasons EXCEPT

A. a tendency to achieve a lower energy condition
B. attractions between nuclei and electrons
C. a tendency for atoms to fill energy levels with electrons
D. a tendency of bonded atoms to react more readily than unbonded atoms

The FALSE statement concerning the nature of chemical bonds is

A. Chemical bonds can result from the simultaneous attraction for valence electrons by two or more nuclei of closely approaching atoms.
B. Separated atoms are more stable than chemically bonded atoms.
C. Chemical bonds can form between closely approaching atoms if their valence electrons are rearranged so as to produce a net attraction between them.
D. Energy is always required to separate atoms or ions that are chemically bonded.

When atoms combine to form a molecule, their energy condition after the bond is formed is

A. less than the separated atoms
B. greater than the separated atoms
C. the same as the separated atoms
D. none of the above

When an H atom and a Cl atom react, a chemical bond can be expected to form because each atom tends to

A. acquire a stable octet
B. acquire a valence orbital population of two electrons each
C. form an ion to obtain an octet of electrons
D. gain electrons to become like the nearest noble gas

UNIT G - CHEMICAL BONDING

Objective 2: Understand the interactions that are involved in chemical bonding

The theory of the electron pair and lone pairs, in the formation of the covalent bond was first proposed by

A. Lewis
B. Gillespie
C. Bohr
D. Rutherford

When potassium metal, $K_{(s)}$, reacts with chlorine gas, $Cl_{2(g)}$, a very strong chemical bond is formed because of simultaneous

A. attractions of shared electrons by the nuclei of atoms
B. attractions of the nuclei of atoms for all the electrons of a neighboring atom
C. attractions of oppositely charged ions
D. repulsions of the valence electrons by neighboring atoms

UNIT G - CHEMICAL BONDING

Objective 3: Distinguish among covalent bonding, ionic bonding, covalent network bonding, and metallic bonding

The compound that would most likely be held together by ionic bonding is

A. $SiCl_4$	C. SCl_2
B. $CaCl_2$	D. BrCl

An example of a molecular compound is

A. NF_3	C. $ZnCl_2$
B. CaS	D. $AgNO_3$

The compound that is molecular is

A. N_2O_4	C. NaCl
B. Li_2O	D. FeS

An ion results from

A. electrons transferring from one atom to another
B. electrons shared between two nonmetallic atoms
C. electrons shared between two metallic atoms
D. nonmetallic complex ions sharing electrons

Element X was found to have the following properties.

1. It formed ionic compounds.
2. It formed anions when bonding ionically.
3. It formed a compound having an empirical formula MgX_2 when combined with magnesium.

The element most likely is a/an

A. alkali metal
B. halogen
C. alkaline earth
D. Group VIA element

The kind of bonding in $HgCl_{2(s)}$ is the result of

A. Hg^{2+} and Cl^- ions attracting each other in a 3-dimensional array
B. only one Hg^{2+} and one Cl^- ion attracting each other
C. Hg^{2+} and Cl^- attracted to shared valence electrons
D. Hg and Cl atoms attracted to shared valence electrons

The type of bonding that is characterized by positive ions attracting free valence electrons is

A. ionic
B. network covalent
C. metallic
D. covalent

Bonding that is characterized by covalent bonding of atoms to adjacent atoms within a 3-D lattice is best illustrated by

A. SiC
B. NaCl
C. CO_2
D. H_2O

The simultaneous attaction of an atom for adjacent atoms within a 3-D lattice of atoms by means of covalent bonds describes the type of bonding found in

A. $SiC_{(s)}$
B. $NaCl_{(s)}$
C. $H_2O_{(s)}$
D. $CO_{2(s)}$

UNIT G - CHEMICAL BONDING

Objective 4: Relate number of valence electrons to the kind of bonding and to bonding substances

A certain atom has one bonding electron, three lone pairs and twenty-eight electrons within its inner energy levels. This atom is

A. chromium
B. sulfur
C. bromine
D. scandium

The following question refers to the imaginary Elements X and Y. Both are found in the upper part of Group IVA of the periodic table. The kind of bonding expected when X and Y combine is.

A. ionic
B. nonpolar covalent
C. network covalent
D. both A and B

The number of lone pairs of electrons around a chemically bonded carbon atom is

A. 0
B. 2
C. 4
D. 2 or 4

The molecule listed below with one lone pair of electrons around its central atom is

A. OF_2
B. CO_2
C. SCl_2
D. NF_3

The number of bonding electrons in atoms of Group VIA elements is

A. 1
B. 2
C. 3
D. 6

The compound that contains a double bond is

A. Br_2
B. N_2H_4
C. N_2
D. C_2H_4

When an atom of calcium collides with an atom of oxygen, electron transfer takes place. The oxygen atom attains an electronic configuration identical to

A. argon
B. neon
C. nitrogen
D. carbon

The number of bonds between nitrogen atoms in a nitrogen molecule is

A. 1
B. 2
C. 3
D. 4

The number of single bonds in one molecule of CH_3COOH is

A. 3
B. 4
C. 5
D. 6

The molecule listed below with a triple bond is

A. C_2H_4
B. HCN
C. CS_2
D. NCl_3

A triple bond is present in

A. N_2H_4
B. CO_2
C. NH_3
D. N_2

The compound that contains a triple bond is

A. O_2
B. NI_3
C. C_3H_8
D. HCN

The following question refers to the imaginary Elements X and Y. Element X is found in Group VIIA and Element Y is found in group VIA of the Periodic Table. The type of substance produced when X and Y react could NOT be characterized by

A. lustrous, good conducting solid
B. gas at room temperature
C. liquid consisting of mobile molecules
D. solid characterized by a crystalline structure

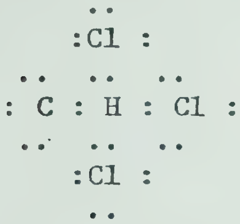
Suppose an Element X is in Group IIA and an Element Y is in Group VIIA, the empirical formula for the compound between X and Y is

A. YX_2
B. YX
C. X_2Y
D. XY_2

UNIT G - CHEMICAL BONDING

Objective 5: Draw Lewis electron-dot diagrams and structural formulas for simple molecules

The correct electron-dot diagram for chloroform, $CHCl_3$, would be

A.


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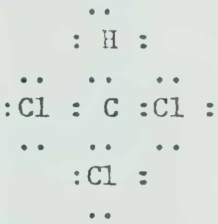

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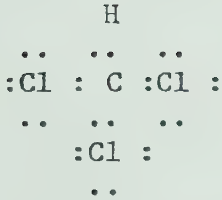

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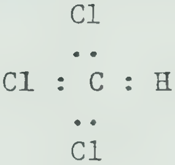
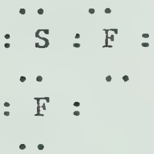
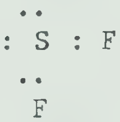


The correct Lewis (electron dot) diagram for SF_2 is

A.


C.


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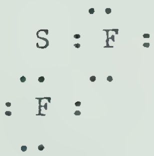

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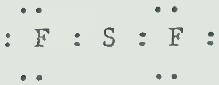

The correct structural formula for N_2H_2FCl is

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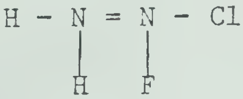
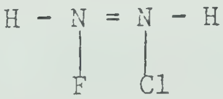
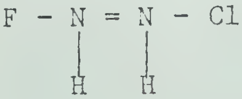


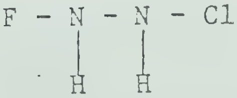
$H-\underset{H}{\underset{|}{N}}=\underset{F}{\underset{|}{N}}-Cl$

C.


$H-\underset{F}{\underset{|}{N}}=\underset{Cl}{\underset{|}{N}}-H$

B.


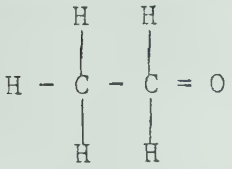
$F-\underset{H}{\underset{|}{N}}=\underset{H}{\underset{|}{N}}-Cl$

D.


$F-\underset{H}{\underset{|}{N}}-\underset{H}{\underset{|}{N}}-Cl$

The correct structural formula for ethanol is

A.



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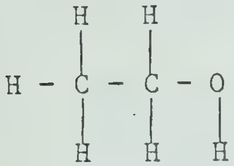

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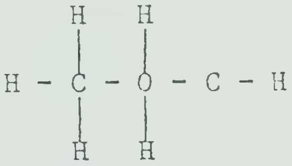

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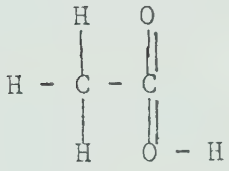
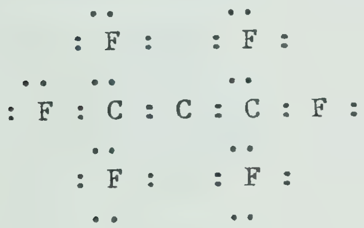


The correct Lewis electron-dot diagram for C_3F_6 is

A.



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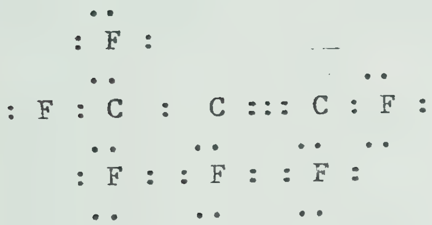
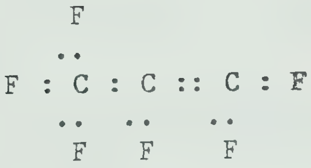


C.



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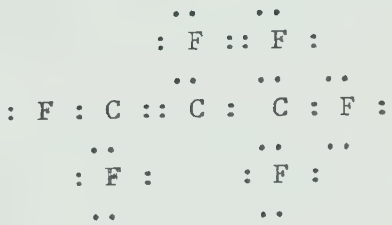


UNIT G - CHEMICAL BONDING

Objective 6: Understand electronegativity and predict the polar nature of bonds

Which statement best explains why fluorine is the most reactive nonmetal?

A. Fluorine is a gas at room temperature.
B. Fluorine has the largest electronegativity of any of the elements on the periodic table.
C. Of all the halogens, fluorine is the one most like its nearest noble gas.
D. It has the lowest atomic number of the halogens.

The electronegativity of atoms

A. always increases with increasing atomic number
B. generally increases in going down a group of the periodic table
C. always increases in going from right to left across a period
D. generally increases in going from left to right across a period

The bond with the strongest bond dipole is

A. C - H
B. O - O
C. N - Cl
D. H - F

The atom with the greatest attraction for a shared pair of electrons in a chemical bond could be an atom in the

A. upper left corner of the periodic table
B. upper right corner of the periodic table
C. lower left corner of the periodic table
D. lower right corner of the periodic table

The CORRECT statement regarding electronegativity is

A. Electronegativity is the actual measured force a nonmetallic atom has for valence electrons.
B. Electronegativity increases from right to left within a period.
C. Electronegativity increases from top to bottom within a group.
D. Electronegativity is smaller for metals than nonmetals.

If the following pairs of atoms were to form a bond, which would be the correct method of representing the bond dipole formed.

1. $\overrightarrow{\mathrm{O - Cl}}$
2. $\overleftarrow{\mathrm{Br - Br}}$
3. $\overleftarrow{\mathrm{N - I}}$
4. $\overleftarrow{\mathrm{C - O}}$
5. $\overrightarrow{\mathrm{S - Br}}$

A. 1, 2, and 3
B. 5 only
C. 1, 3, and 4
D. 3 and 5

Francium is assigned the lowest electronegativity number because

A. Francium belongs to Group IA which is farthest from the noble gas family in the periodic table.
B. Francium is a metallic atom.
C. Francium has the smallest attractive force for shared electrons
D. Francium exist as solid in room temperature and this means it has the least amount of energy to hold on to its valence electrons.

The molecule which contains NONPOLAR COVALENT bonding is

A. CI_4
B. CCl_4
C. OF_2
D. CO_2

The electronegativity of atoms always decreases as

A. the atomic number decreases within a group
B. the nonmetallic property of atoms increases within a period
C. the metallic property of atoms increases within a group
D. the number of valence electron of atoms increases within a period

The most polar covalent bond is

A. N - O
B. H - F
C. Na - Cl
D. C - S

The CORRECT statement pertaining to electronegativity is

A. Electronegativity is the relative force of attraction between metallic atoms and non-metallic atoms.
B. Electronegativity causes the movement of atoms towards one another.
C. Electronegativity is the relative attraction which a nonmetallic atom has for a lone pair electron.
D. Electronegativity is the relative attraction that an atom has for shared paired electrons in a covalent bond.

The reason the electronegativity of fluorine is assigned the highest arbitrary number is that fluorine

A. has the greatest tendency to share electrons
B. has the greatest attraction for shared pair electrons
C. exists as a gas at room temperature, therefore should have the greatest energy for bonding
D. has the lowest boiling point of all the elements in the periodic table, therefore, the most reactive

UNIT G - CHEMICAL BONDING

Objective 7: Predict the shapes around central atoms of simple molecular substances, and determine the polar nature of molecules

The V-shaped molecule listed below is

A. H_2S
B. CO_2
C. O_3
D. HCN

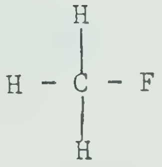
The substance below which represents a polar molecule would be

A. NH_3
B. C_2H_4
C. CCl_4
D. CO_2

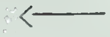
The molecular formula that represents a polar molecule is

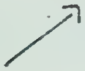
A. CCl_4
B. HCN
C. C_2F_2
D. C_2H_4

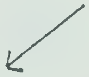
The correct representation for the molecular dipole of the molecule shown to the right is

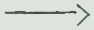


$\mathrm{H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-F}$

A. 

B. 

C. 

D. 

The nonpolar molecule listed below is

A. NF_3
B. C_2H_6
C. H_2O
D. $CHCl_3$

Use this information to answer the following question(s).

Substance 1 is CH_4
Substance 2 is I_2
Substance 3 is H_2
Substance 4 is BF_3
Substance 5 is H_2S
Substance 6 is C_2H_2

The substances that are linear in shape are

A. 2 and 6 only
B. 2, 3, and 6 only
C. 2, 4, and 5 only
D. 2, 3, and 5 only

The substance that possesses a multiple bond is

A. 3
B. 4
C. 5
D. 6

The shape around each C atom in C_2H_3Cl is

A. trigonal planar
B. modified trigonal planar
C. tetrahedral
D. modified tetrahedral

The chemical formula of a compound which consists of pyramidal shaped molecules is

A. CCl_4
B. H_2S
C. C_2H_2
D. NF_3

The substance that is V-shaped around the central atom is

A. CO_2
B. BF_3
C. H_2S
D. NH_2F

Of the molecules listed below, the one exhibiting a pyramidal shape around the central atom is

A. SO_2
B. InF_3
C. NH_3
D. C_2H_4

The molecule listed below with a trigonal planar shape around a central atom is

A. NF_3
B. PBr_3
C. OF_2
D. C_2H_4

The shape around the O atom in Cl_2O is

A. linear
B. V-shaped
C. pyramidal
D. trigonal planar

The shape around the central atom of H_2O_2 is

A. V-shaped
B. pyramidal
C. trigonal planar
D. tetrahedral

The shape around the carbon atom in CH_3OH is

A. tetrahedral
B. trigonal planar
C. pyramidal
D. V-shaped

The shape around each carbon atom in C_3H_3 is

A. trigonal planar
B. tetrahedral
C. V-shaped
D. pyramidal

The shape around each carbon in C_2Cl_4 is

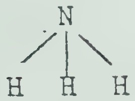
A. pyramidal
B. trigonal planar
C. tetrahedral
D. linear

The shapes around the central atoms of the molecule CH_3NHOH are

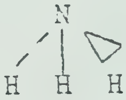
A. tetrahedral, pyramidal, V-shaped
B. linear, tetrahedral, V-shaped
C. trigonal planar, tetrahedral, linear
D. tetrahedral, pyramidal, linear

The most likely formula illustrating the actual shape of a molecule of NH_3 is

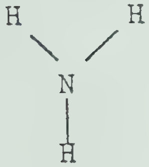
A.



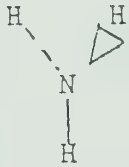
C.



B.



D.



The linear molecule with no bond dipole is

A. CO_2
B. OCl_2
C. N_2
D. P_4

The triatomic linear molecule listed below is

A. K_2O
B. C_2H_2
C. OF_2
D. CO_2

UNIT G - CHEMICAL BONDING

Objective 8: Understand the nature of intermolecular forces

The situation that does NOT involve intermolecular bonding is

A. methane molecules attracting methane molecules
B. the sulfur atom in an H_2S molecule attracting the hydrogen atoms
C. the hydrogen atom of H_2O attracting the oxygen atom of CH_3OH
D. forces of attraction holding molecules of H_2O together in ice

Atoms A, B, and C are in the same period and have two, five, and seven valence electrons respectively. The chemical formula of a molecular compound that would most likely exhibit weakest intermolecular forces of attraction is

A. A_3B
B. AC
C. BC_3
D. C_2

UNIT G - CHEMICAL BONDING

Objective 9: Distinguish between the two main kinds of intermolecular forces - van der Waals forces (including dipole-dipole forces and London dispersion forces) and hydrogen bonding

The substance which exhibits the weakest London dispersion forces is

A. Ar
B. Ne
C. CCl_4
D. CO_2

London dispersion forces would be strongest in the substance

A. H_2
B. O_2
C. F_2
D. Br_2

The true statement regarding London dispersion forces is

A. All of the below.
B. The more electrons the molecule of a substance has the stronger the force.
C. The more closely packed the molecules are, the stronger the force.
D. The more symmetrical the molecules are, the stronger the force.

Intermolecular bonding forces among CO_2 molecules can involve

A. dipole-dipole
B. London dispersion forces
C. covalent bonding
D. network covalent bonding

Use the data below to answer the following question(s).

Atoms A, B, and C are in the same period and have two, five, and seven valence electrons respectively.

The chemical formula that will represent a substance that involves dipole-dipole intermolecular forces of attraction is

A. B_2
B. C_2
C. BC_3
D. A_3B_2

The chemical formula that will represent a substance that exists naturaly as an ionic solid is

A. AC_2
B. B_2
C. BC_3
D. C_2

Dipole-dipole intermolecular forces could be found in

A. H_2

B. CO_2

C. HBr

D. C_2H_4

The substance which exhibits only dipole-dipole forces and London dispersion forces is

A. C_2H_5OH

B. Cl_2

C. OF_2

D. C_2H_4

The substance below that will NOT display van der Waals as the most significant type of bonding is

A. CH_4

B. C_2H_4

C. CF_4

D. Na_2CO_3

Hydrogen bonding occurs when

A. a high electronegativity atom and hydrogen is present
B. a metallic atom and hydrogen atom is present
C. hydrogen atoms are sharing electrons with either sulfur or nitrogen
D. fluorine atom is joined with chlorine, nitrogen, or oxygen

The substance that exhibits hydrogen bonding is

A. C_2H_6

B. H_2

C. H_2S

D. CH_3CH_2OH

The molecule that can form two hydrogen bonds is

A. H_2O_2

B. HF

C. C_2H_6

D. H_2S

The substance which does NOT exhibit hydrogen bonding is

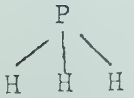
A. $HBr_{(g)}$

B. $C_2H_5OH_{(1)}$

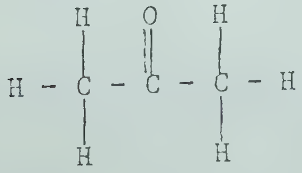
C. $CH_3NH_{2(g)}$

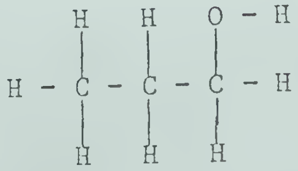
D. $HF_{(g)}$

The structural formula that represents a molecule that would exhibit hydrogen bonding is

A.


C. $H - H$

B.

$$\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{O}{\overset{\|}{C}}-\overset{H}{\underset{H}{C}}-H}$$

D.

$$\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{O-H}{\underset{H}{C}}-H}$$

The number of intermolecular bondings that the following molecules have (in the order they are given) are

Molecule A	Molecule B	Molecule C	Molecule D
CS_2	$HCCl_3$	CH_3CH_2OH	C_6H_5COOF

A. 1, 2, 3, 2
B. 2, 1, 2, 3
C. 3, 2, 1, 1
D. 2, 3, 3, 1

Given the following molecules, the one that has all three types of intermolecular bonding is

A. $C_6H_5NCl_2$
B. CH_3COOH
C. C_2H_3F
D. $Ca(OH)_2$

If the following types of bonding were classified from strongest to weakest they would be ranked

A. ionic, dipole-dipole, hydrogen, network covalent
B. network covalent, ionic, hydrogen, dipole-dipole
C. hydrogen, dipole-dipole, ionic, network covalent
D. network covalent, dipole-dipole, hydrogen, ionic

UNIT G - CHEMICAL BONDING

Objective 10: relate types of intermolecular forces to some properties of molecular substances

Consider the four compounds: HF, H_2S, HBr, and HI. Based on the kind of molecular forces that operate between the molecules of each compound in the liquid phase, the compound with the highest boiling point is most likely

A. HF
B. H_2S
C. HBr
D. HI

When Na, SiO_2, C_2H_5OH and C_3H_8 are listed in order of increasing boiling point the correct order is

A. C_3H_8, C_2H_5OH, Na, SiO_2
B. Na, SiO_2, C_3H_8, C_2H_5OH
C. SiO_2, C_3H_8, Na, C_2H_5OH
D. C_2H_5OH, C_3H_8, Na, SiO_2

Given the following four compounds, H_2O, H_2S, H_2Se, and H_2Te. The compound with the highest boiling point would most likely be

A. H_2O
B. H_2S
C. H_2Se
D. H_2Te

$IBr_{(s)}$ has a relatively low melting point. This is the result of the presence of

A. ionic bonding
B. dipole-dipole forces
C. London dispersion forces
D. network covalent bonding

The reason why acetic acid, $CH_3COOH_{(aq)}$, is more soluble in water than acetylene, C_2H_2, is

A. Acetylene is attracted to water by dipole-dipole force.
B. Acetylene has a lower molar mass than acetic acid.
C. Acetic acid has more electrons.
D. Acetic acid is polar whereas acetylene is not.

In comparing $SiO_{2(s)}$ and $MgSO_{4(s)}$, which of the following statements would be FALSE?

A. $MgSO_4$ would dissolve in H_2O to form a conducting solution.
B. SiO_2 would have a lower melting point than $MgSO_4$.
C. SiO_2 would be insoluble in H_2O.
D. SiO_2 is harder than $MgSO_4$.

UNIT H - ORGANIC CHEMISTRY

Objective 1: Distinguish between organic and inorganic compounds

Which of the following is NOT an organic substance?

A.	HCN	C.	C_2H_6O
B.	CH_4	D.	CH_3COOH

Which of the following compounds are considered to be organic compounds?

1. CH_3OH 2. CaC_2 3. C_2H_5COOH 4. $MgCO_3$ 5. HCN

A. 1, 3, and 5
B. 2 and 4
C. 5 only
D. 1 and 3

Which of the following is an organic substance?

A.	H_2CO_3	C.	HOCN
B.	$Ba(C_{17}H_{35}COO)_2$	D.	CH_3Br

Which statement about organic compounds is FALSE?

A. Organic compounds include all compounds of carbon.
B. Organic compounds include those compounds derived from living organisms.
C. Organic compounds include numerous synthetic substances.
D. Presently between three and four million organic compounds are known.

Organic substances include those derived from living organisms as well as synthetic substances. An example of a substance which is NOT an organic material is

A. foodstuffs (fats, proteins, carbohydrates)
B. grease and lubricating oils
C. soap and detergents
D. carbonated beverages (pop)

UNIT H - ORGANIC CHEMISTRY

Objective 2 - Recognize hydrocarbons and distinguish between the aliphatic hydrocarbons (including alkanes, alkenes, and alkynes) and aromatic hydrocarbons

An alkyne is represented by the molecular formula

A. C_3H_6
B. C_4H_6
C. C_5H_{12}
D. C_6H_6

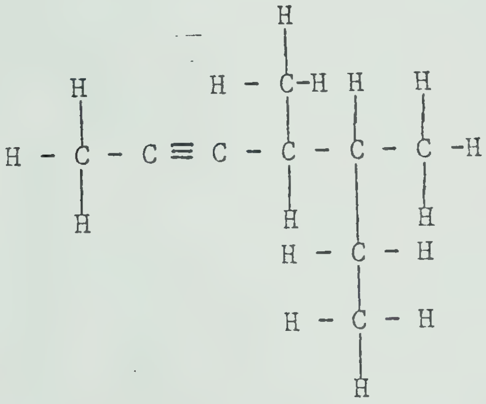
Which of the following compounds is a saturated aliphatic?

A. $C_6H_5CH_3$
B. C_7H_{16}
C. C_9H_{18}
D. C_5H_8

UNIT H - ORGANIC CHEMISTRY

Objective 3: Name and write structural formulas for the first ten members of the alkane, alkene and alkyne series and some of their simpler isomeric forms and name derivative compounds of benzene

The name of



is

A. 4-methyl-5-ethyl-2-hexyne
B. 4-methyl-5-ethyl-2-hexene
C. 4,5-dimethyl-2-heptyne
D. 2-ethyl-3-methyl-4-hexyne

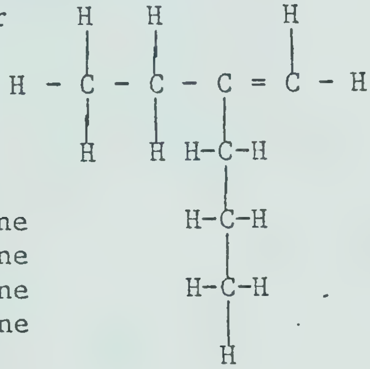
The correct name for $CH_3 - C \quad C - CH(CH_3) - CH(C_2H_5) - C_3H_7$ is

A. 4-methyl-5-ethyl-2-octyne
B. 1-propyl-2-ethyl-3-methyl-4-hexyne
C. 4-ethyl-5-methyl-6-octyne
D. 4-methyl-5-propyl-2-heptyne

The name for $CH_3C(CH_3)_2CCCH_3$ is

A. 2-heptyne
B. 2, 2-methyl-3-pentyne
C. 2, 2-dimethyl-2-pentyne
D. 4, 4-dimethyl-2-pentyne

The correct name for



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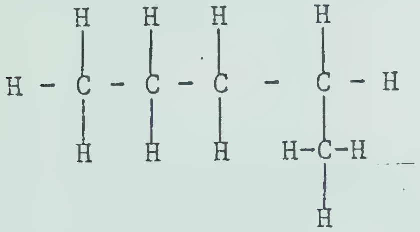
is

A. 2-propyl-1-butene
B. 2-ethyl-1-pentene
C. 3-propyl-3-butene
D. 2-ethyl-2-pentene

Use this information to answer the following question(s).

1.



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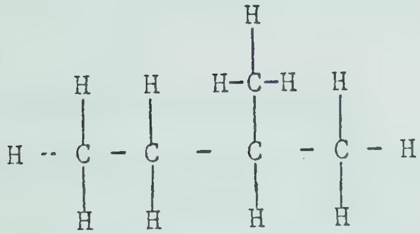
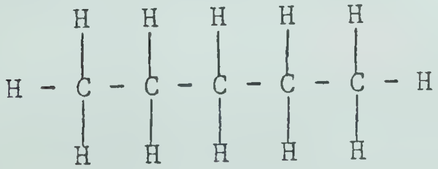
2.



$$\begin{array}{ccccccccccc} & & & & & & H & & & & \\ & & & & & & \mid & & & & \\ & & H & & H & & H{-}C{-}H & & H & & \\ & & \mid & & \mid & & \mid & & \mid & & \\ H & - & C & - & C & - & C & - & C & - & H \\ & & \mid & & \mid & & \mid & & \mid & & \\ & & H & & H & & H & & H & & \end{array}$$

3.



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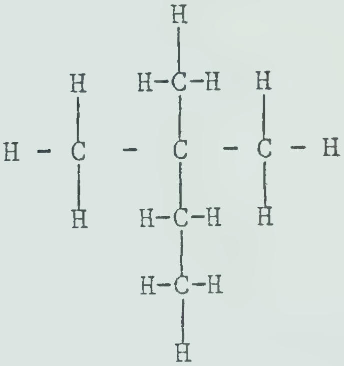
4.



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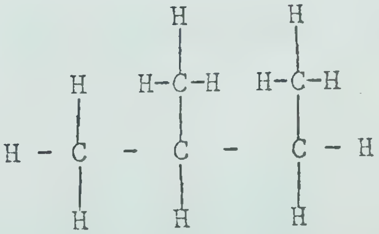
5.



$$\begin{array}{ccccccccc} & & & & H & & H & & \\ & & & & \mid & & \mid & & \\ & & H & & H{-}C{-}H & & H{-}C{-}H & & \\ & & \mid & & \mid & & \mid & & \\ H & - & C & - & C & - & C & - & H \\ & & \mid & & \mid & & \mid & & \\ & & H & & H & & H & & \end{array}$$

The number of different compounds represented above is

A. 2
B. 3
C. 4
D. 5

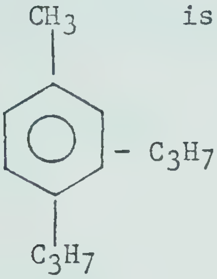
Four of the compounds given above are named below. Which name does NOT correctly identify the compound?

A. Compound 1 1-methylbutane
B. Compound 2 2-methylbutane
C. Compound 4 2,2-dimethylbutane
D. Compound 5 2-methylbutane

The molecular formula for the third member of the alkyne series is

A. C_3H_8
B. C_3H_4
C. C_3H_6
D. C_4H_6

The name of



is

A. 1-methyl-3,4-dipropylbenzene
B. 1,2-dipropyl-4-methylbenzene
C. 4-methyl-1,2-dipropylbenzene
D. 3,4-dipropyl-1-methylbenzene

UNIT H - ORGANIC CHEMISTRY

Objective 4: Describe the characteristic bond type associated with the alkanes, alkenes, alkynes, and benzene

The carbon-carbon bonds in benzene are

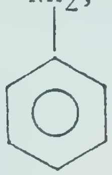
A. identical to the carbon-carbon bonds in cyclohexane
B. identical to the carbon-carbon bonds in cyclohexene
C. a hybrid between a double and single bonds
D. easily broken in chemical reactions

The number of electrons that are shared in a hydrogen-carbon bond is

A. one
B. two
C. four
D. six

Acetylene is classified as an unsaturated hydrocarbon. Acetylene is unsaturated because
A. It is available both as a liquid or a gas.
B. It is the first member of the alkenes.
C. There are no possible isomers.
D. It is a member of the alkyne series.

Shapes present in aniline, NH_2, are



A. trigonal planar only
B. trigonal planar and pyramidal
C. tetrahedral and trigonal planar
D. pyramidal and tetrahedral

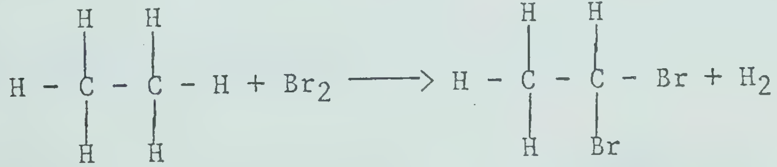
The compound that contains a trigonal planar shape about one of its central atoms is

A. C_4H_{10}
B. C_6H_{12}
C. C_8H_{14}
D. C_2H_5OH

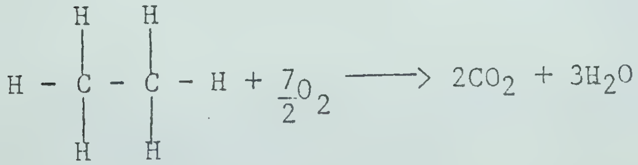
UNIT H - ORGANIC CHEMISTRY

Objective 5: Describe and account for some physical and chemical properties characteristic of alkanes, alkenes, alkynes, and benzene

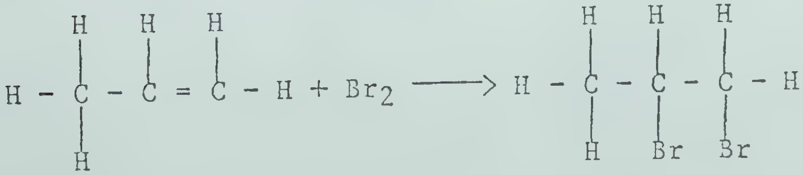
The equation that represents an addition reaction is

A. 

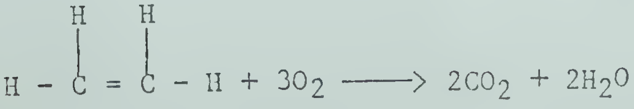
$$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H + Br_2 \longrightarrow H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{Br}{C}}-Br + H_2$$

B. 

$$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

C. 

$$H-\overset{H}{\underset{H}{C}}-\overset{H}{C}=\overset{H}{C}-H + Br_2 \longrightarrow H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{Br}{C}}-\overset{H}{\underset{Br}{C}}-H$$

D. 

$$H-\overset{H}{C}=\overset{H}{C}-H + 3O_2 \longrightarrow 2CO_2 + 2H_2O$$

Which of the following is NOT a property of alkanes?

A. They are soluble in water.
B. They have weak intermolecular attractions.
C. The boiling point increases as the number of carbons increase.
D. They are unreactive under ordinary conditions.

To rank alkanes, alkenes and alkynes in terms of reactivity, with the most reactive compound listed first, the correct order of reactivity would be

A. alkanes, alkenes, alkynes
B. alkenes, alkynes, alkanes
C. alkynes, alkenes, alkanes
D. alkynes, alkanes, alkenes

Propane ($C_3H_{8(g)}$) has low solubility in water. This is due to the fact that

A. C_3H_8 is a gas.
B. C_3H_8 is nonpolar and water is polar.
C. Both propane and water are nonpolar.
D. C_3H_8 is polar and water is nonpolar.

Aliphatic hydrocarbons have very similar physical properties. Identify the FALSE statement.

A. The boiling point increases as the number of carbon atoms per molecule increases.
B. Aliphatic hydrocarbons are nonpolar molecules.
C. Aliphatic hydrocarbons can be obtained from crude oil by fractional distillation.
D. Aliphatic hydrocarbons are soluble in solvents such as water, hydrochloric acid and sodium hydroxide solution.

Chlorine gas, $Cl_{2(g)}$, is reacted with several hydrocarbons. In which compound would one of the products of the reaction most likely be hydrogen chloride, $HCl_{(g)}$?

A. C_3H_6
B. C_5H_8
C. C_5H_{10}
D. C_6H_6

A few drops of bromine, Br_2, is added to the following hydrocarbons. In which of the following would the color of the bromine disappear the fastest?

A. C_4H_{10}
B. C_6H_6
C. C_7H_{14}
D. C_8H_{18}

The substance listed below that would exist in a gaseous phase at room temperature is

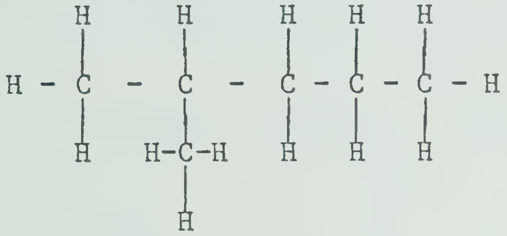
A. 1 - octanol
B. 2, 2, 4 - trimethylpentane
C. 2 - decene
D. ethane

Chemical properties of an unknown organic compound were tested with bromine and potassium permanganate solution. It was found that the unknown compound decolorizes potassium permanganate solution and gave a nonacidic product with bromine. The unknown organic compound is most likely to be

A. pentane	C. hexane
B. octene	D. benzene

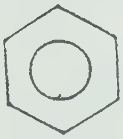
T Use the following information to answer the following question(s).

1.

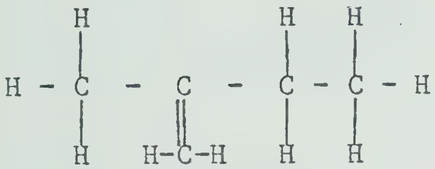


$H-\underset{H}{\overset{H}{C}}-\underset{\underset{H}{H-C-H}}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

2.



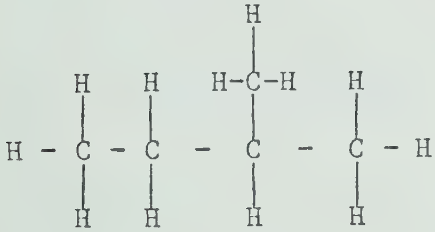
3.



$H-\underset{H}{\overset{H}{C}}-\underset{\underset{H-C-H}{\|}}{C}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

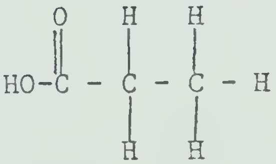
4. $O = C = O$

5.



$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{\overset{H}{H-C-H}}{C}}-\underset{H}{\overset{H}{C}}-H$

6.



$HO-\overset{\overset{O}{\|}}{C}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

T* The formula(s) which does NOT represent an organic compound is(are)

A. 2 only	C. 4 and 5
B. 4 only	D. 2 and 4

T* An alkane is represented by

A. 1 only	C. 1 and 5
B. 1 and 3	D. 1, 5, and 6

T* The unsaturated organic compound(s) is(are) represented by

A. 3 only	C. 3 and 4
B. 2 and 3	D. 3, 4, and 6

The organic compounds(s) that will undergo an addition reaction is (are)

A. 3 only
B. 2 and 3
C. 3 and 4
D. 3 and 6

Given 1 mol of the substances below, the compound that would require the most Br_2 for an addition reaction is

A. C_4H_{10}
B. C_5H_{12}
C. C_6H_{10}
D. C_7H_{14}

UNIT H – ORGANIC CHEMISTRY

Objective 6: Identify some of the more common hydrocarbons and describe some of their uses

Use these organic compounds to answer the following question(s).

1. CH_4
2. C_2H_4
3. C_2H_2
4. CCl_4
5. C_6H_6
6. C_2H_5OH
7. CH_3COOH
8. $HCOOCH_2CH_3$

The compound NOT used as a fuel is

A. 1
B. 3
C. 4
D. 6

The most likely compound that might be used used as flavoring agent is

A. 2
B. 4
C. 5
D. 8

The most likely compound might be used as a dressing for salads is

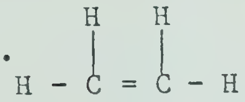
A. 7
B. 5
C. 3
D. 1

The most likely compound used as a starting compound for plastic is

A. 2
B. 5
C. 6
D. 8

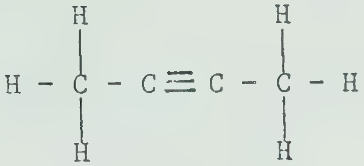
The structural formula of a member of the alkyne series used in oxyacetylene welding is

A.



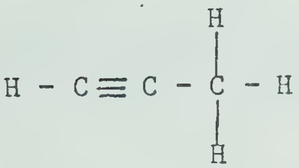
$H-\overset{H}{C}=\overset{H}{C}-H$

C.



$H-\overset{H}{\underset{H}{C}}-C\equiv C-\overset{H}{\underset{H}{C}}-H$

B.

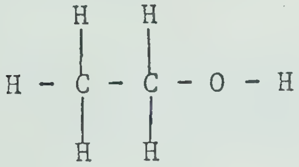


$H-C\equiv C-\overset{H}{\underset{H}{C}}-H$

D. $H-C\equiv C-H$

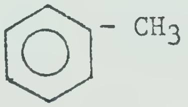
The starting material for a common plastic is most likely

A.

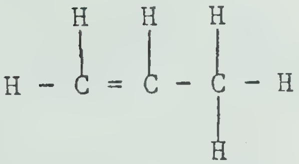


$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-O-H$

C.

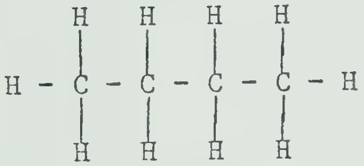


B.



$H-\overset{H}{C}=\overset{H}{C}-\overset{H}{\underset{H}{C}}-H$

D.



$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H$

UNIT H - ORGANIC CHEMISTRY

Objective 7: Recognize the application of such processes as fractional distillation, catalytic cracking and polymerization

The separation of the various components of crude petroleum by the differences of their boiling point is known as

A. fractional distillation
B. catalytic cracking
C. thermal reforming
D. thermal cracking

The conversion of large hydrocarbon molecules into smaller molecules is known as

A. catalytic reforming
B. catalytic or thermal cracking
C. fractional distillation
D. organic decompostion

The process used to join individual molecules of an organic compound together to form a chain of identical repeating units of that compound is referred to as

A. fractional distillation
B. catalytic cracking
C. esterification
D. polymerization

An organic compound most commonly used as a starting compound in the manufacture of products such as antifreeze, tetraethyl lead, paints, drugs, polyester is

A. methane
B. carbon tetrachloride
C. ethylene
D. 1-butanol

Diamonds are artifically made by subjecting powdered graphite to high temperatures and pressures to make a tremendously large molecule composed only of carbon. This process is called

A. hydrocarbon combustion
B. polymerization
C. catalytic cracking
D. stoichiometry

The process commonly used to convert high molar mass hydrocarbons into low molar mass hydrocarbons is called

A. cracking
B. combustion
C. substitution reaction
D. fractional distillation

Crude petroleum is a complex mixture of hydrocarbons. The process involved in separation, purification, and increasing the yield of the desirable components of crude petroleum is called

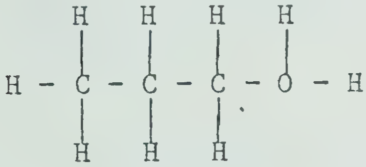
A. cracking
B. reforming
C. fractional distilling
D. refining

UNIT H - ORGANIC CHEMISTRY

Objective 8: Name, identify the functional group and its structure, and describe and account for some physical and chemical properties of some alcohols, carboxylic acids and esters

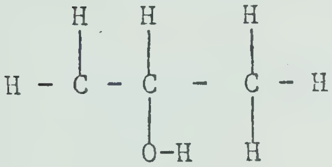
The compound that is NOT an isomer of the others is

A.



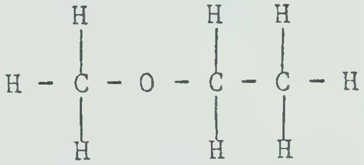
$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\overset{H}{O}-H$

B.



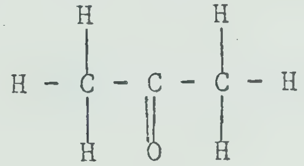
$H-\overset{H}{C}-\underset{O-H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

C.



$H-\underset{H}{\overset{H}{C}}-O-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

D.



$H-\underset{H}{\overset{H}{C}}-\underset{\Vert \atop O}{C}-\underset{H}{\overset{H}{C}}-H$

The compound that is the most soluble in water is

A. ethanol
B. 1-pentanol
C. 1-hexanol
D. 3-octanol

The statement that is TRUE of organic acids is

A. They do not exhibit hydrogen bonding.
B. They have no properties in common with inorganic acids.
C. They react with alcohols to form esters.
D. They all have a low solubility in water.

Of the compounds below, the one that would have the lowest boiling point would be

A. C_4H_{10}
B. C_8H_{18}
C. CH_3CH_2COOH
D. CH_3OH

The substance listed below that would readily dissolve in water is

A. $CH_3CH_2CH_2CH_3$
B. CH_3COOH
C. C_6H_6
D. $CH_3COOCH_2CH_3$

Some organic compounds exhibit these properties:

1. turn litmus paper red
2. soluble in water
3. reacts with metal
4. exhibit hydrogen bonding

These organic compounds are most likely to be

A. alkanes
B. acids
C. alcohols
D. esters

* Use the data obtained for five organic compounds to answer the following question(s).

COMPOUND	Boiling point	Soluble in water?	Addition reaction of one mole of compound with Br_2
Compound 1	-50°C	no	no
Compound 2	-10°C	no	yes (1 mol Br_2)
Compound 3	80°C	yes	no
Compound 4	95°C	yes	yes (1 mol Br_2)
Compound 5	-20°C	no	yes (2 mol Br_2)

* The compound that is an alkyne is

A. Compound 2
B. Compound 3
C. Compound 4
D. Compound 5

* The compound that is an alkane is

A. Compound 1
B. Compound 2
C. Compound 3
D. Compound 4

T* The compound that could be an alcohol containing a carbon-carbon double bond is

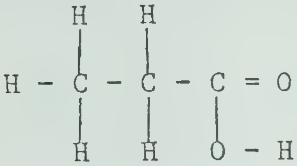
A. Compound 2
B. Compound 3
C. Compound 4
D. Compound 5

T The compound that could be a saturated carboxylic acid is

A. Compound 1
B. Compound 2
C. Compound 3
D. Compound 4

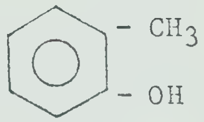
The compound in which London dispersion forces are the only significant intermolecular forces present is

A.

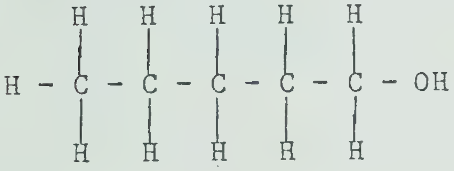


$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{O-H}{C}=O$

C.

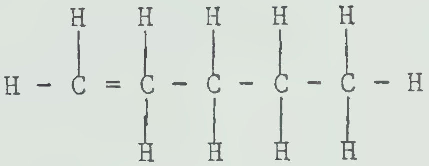


B.



$H-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-OH$

D.



$H-\overset{H}{C}=\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-H$

UNIT H - ORGANIC CHEMISTRY

Objective 9: Recognize the process of esterification and relate the products (esters) to their natural occurrence

The reaction of propanol with butanoic acid is an example of the process known as

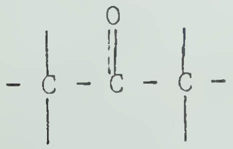
A. esterification
B. combustio
C. addition
D. substitution

$CH_3COOC_2H_5$ is an example of an

A. organic acid
B. ester
C. alcohol
D. none of the above

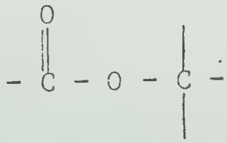
The structural formula of an ester can be identified by the presence of which one of the following isolated functional groups?

A.



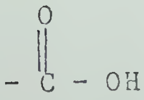
$-\underset{|}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}-\underset{|}{\overset{|}{C}}-$

C.



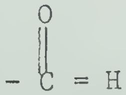
$-\overset{O}{\overset{\|}{C}}-O-\underset{|}{\overset{|}{C}}-$

B.



$-\overset{O}{\overset{\|}{C}}-OH$

D.



$-\overset{O}{\overset{\|}{C}}=H$

Ethyl butanoate is a substance which is used as an artificial peach flavor. The correct molecular formula for ethyl butanoate is

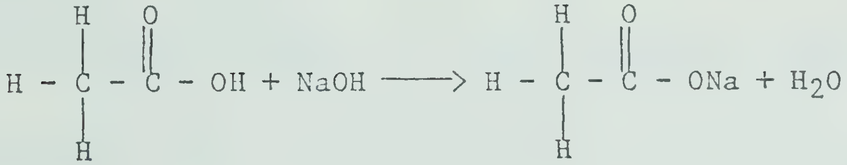
A. $C_4H_9COOC_2H_5$

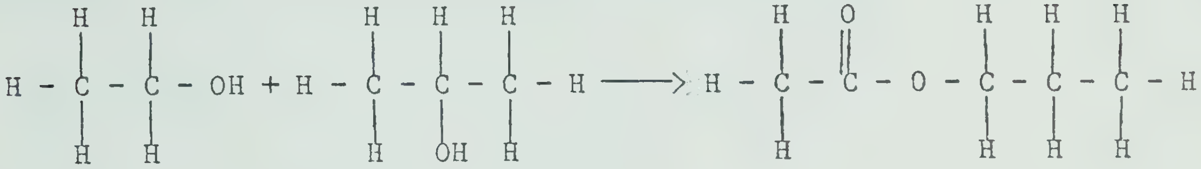
B. $CH_3COOC_4H_9$

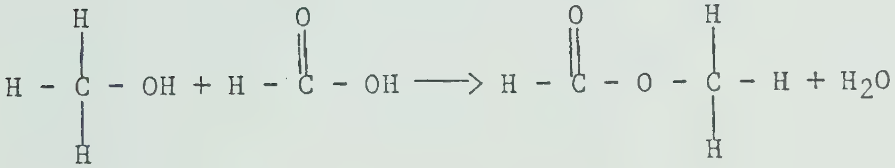
C. $C_3H_7COOC_2H_5$

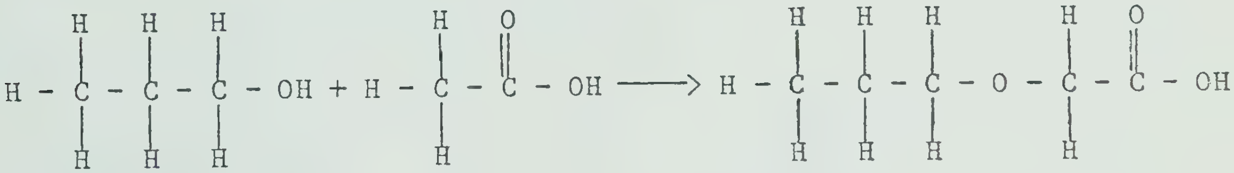
D. $C_2H_5COOC_4H_9$

An example of a balanced equation for an esterification reaction is

A.

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

B.

$CH_3CH_2OH + CH_3CH(OH)CH_3 \rightarrow CH_3COOCH_2CH_2CH_3$

C.

$CH_3OH + HCOOH \rightarrow HCOOCH_3 + H_2O$

D.

$CH_3CH_2CH_2OH + CH_3COOH \rightarrow CH_3CH_2CH_2OCH_2COOH$

A student has been asked to prepare octyl ethanoate, an artificial orange flavor. The student could prepare the octyl ethanoate by reacting

A. heptanol and ethanoic acid
B. octanol and ethanoic acid
C. ethanol and octanoic acid
D. octanol and methanoic acid

UNIT H - ORGANIC CHEMISTRY

Objective 10: Identify some of the common alcohols, organic acids and benzene derivatives and describe some of their uses

Which of the following is an INCORRECT name for CH_3COOH?

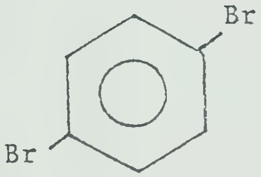
A. ethanedioic acid
B. ethanoic acid
C. acetic acid
D. vinegar

Another name for wood alcohol is

A. 2-phenylpropane
B. ethanol
C. methanol
D. 2-propanol

The name for the substance represented by the formula to the right is

A. metadibromobenzene
B. orthodibromobenzene
C. paradibromobenzene
D. parabromobenzene



Citric acid is

A. used to make vinegar
B. used in the baking industry to control fungus growth
C. the aromatic compound found in oil of wintergreen
D. found in oranges

UNIT H - ORGANIC CHEMISTRY

Objective 11: Define and use the terms concentrated, dilute, solute, solvent, miscrible, saturated and aqueous.

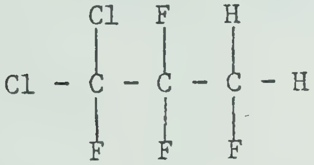
Four methyle halides are given below.

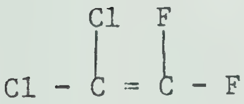
1. CH_3I
2. CH_3F
3. CH_3Cl
4. CH_3Br

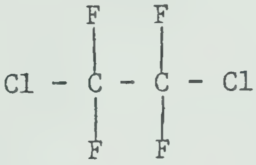
If the boiling point of 1. is 43° C and 2. is -78°C and 3. is -24°C, the most likely boiling point of 4. is

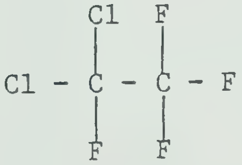
A. 50°C
B. 4°C
C. -30°C
D. -90°C

The compound freon-114 or 1,1-dichloro-1,2,2,2-tetrafluorethane is indicated by

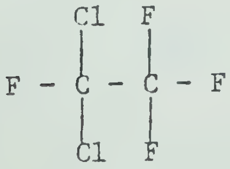
A.

$\mathrm{Cl{-}CClF{-}CF_2{-}CHF{-}H}$

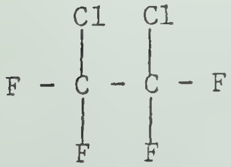
B.

$\mathrm{Cl{-}CCl{=}CF{-}F}$

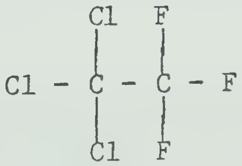
C.

$\mathrm{Cl{-}CF_2{-}CF_2{-}Cl}$

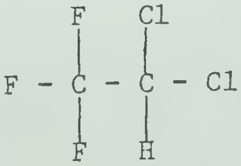
D.

$\mathrm{Cl{-}CClF{-}CF_2{-}F}$

The correct structural formula for 1,1-dichloro-1,2,2,2-tetrafluoroethane is

A.

$\mathrm{F{-}CCl_2{-}CF_2{-}F}$

B.

$\mathrm{F{-}CClF{-}CClF{-}F}$

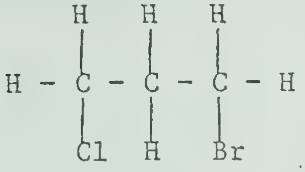
C.

$\mathrm{Cl{-}CCl_2{-}CF_2{-}F}$

D.

$\mathrm{F{-}CF_2{-}CClH{-}Cl}$

From the organic halides listed below, the substance with the highest boiling point is

A. 1,1-dichloroethane
B. 1,1-dibromoethane
C. 1,1-diiodoethane
D. 1,1-difluoroethane

The name given to the organic halide shown below is



$\mathrm{H-\underset{Cl}{\overset{H}{C}}-\underset{H}{\overset{H}{C}}-\underset{Br}{\overset{H}{C}}-H}$

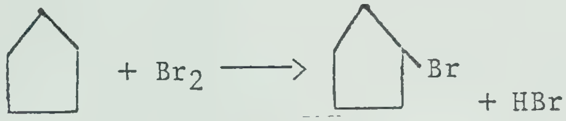
A. chlorobromopropane
B. 1-bromo-3-chloropropane
C. 1,3-dichlorobromopropane
D. chloropropylbromide

UNIT H - ORGANIC CHEMISTRY

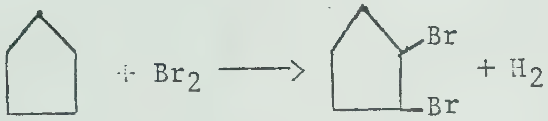
Objective 12: (optional) Name, write structural formulas for and list chemical and physical properties of cycloalkanes and cycloalkenes

Which of the following reactions shows the correct reaction between cyclopentane and bromine?

A.



B.



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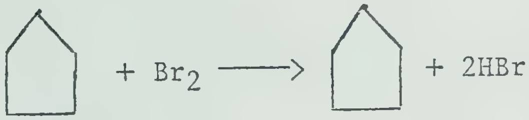

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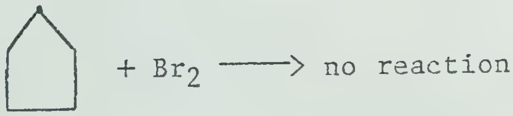
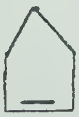
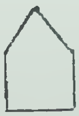
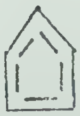
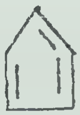


D The correct chemical formula for cyclopentene is

A. 

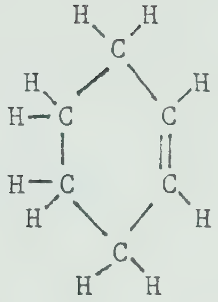
B. 

C. 

D. 

The correct name for the substance to the right is

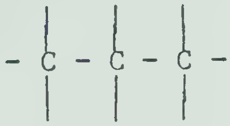
A. benzene
B. hexene
C. cyclohexane
D. cyclohexene

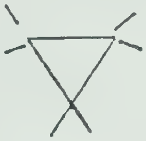


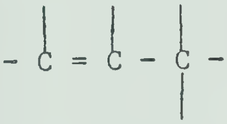
Compound properties found:

1. Compound has general formula of C_nH_{2n}.
2. Compound undergoes addition reaction under proper condition but will also undergo substitution reaction.
3. Compound has higher boiling point and density than the corresponding alkane.

The most likely compound with these properties is

A.

$-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$

C.


B.

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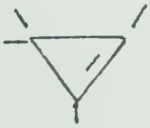
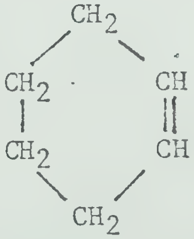
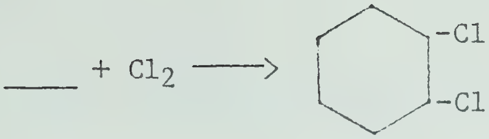
D.


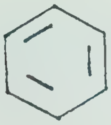
D The name given to the formula shown to the right is

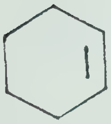
A. 1-hexene
B. 1-cyclohexene
C. cyclohexene
D. 2-cyclohexene

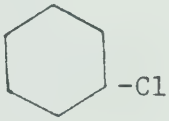




The most likely reactant for the reaction above would be

A. 

B. 

C. 

D. $CH_3CH_2CH_2CH_2CH_2CH_2Cl$

UNIT I - SOLUTIONS

Objective 1: Define and use the terms concentrated, dilute, solute, solvent, saturated and aqueous

Substances that dissolve each other in all proportions are said to be

A. saturated
B. diluted
C. aqueous
D. miscible

The notation NOT characterizing a solution is

A. $HCl_{(g)}$
B. $Br_{2(alcohol)}$
C. $C_{12}H_{22}O_{11(aq)}$
D. $Cl_{2(CCl_4)}$

An aqueous solution means

A. an acid has been formed
B. a solute has reacted
C. dissociation has taken place
D. the solvent is water

The TRUE statement pertaining to the solution $Br_{2(CCl_4)}$ should be

A. The solvent is bromine.
B. There is an apparent change in phase when bromine dissolves in carbon tetrachloride.
C. The solute is bromine.
D. Solution should not be formed because bromine is not soluble in carbon tetrachloride.

A Bunsen burner is used to heat up 100 mL of a dilute salt solution in an open beaker. After 15 min, the Bunsen burner is turned off. The resultant solution is said to be

A. more concentrated than the original solution
B. less concentrated than the original solution
C. more miscible than the original solution
D. less saturated than the original solution.

UNIT I - SOLUTIONS

Objective 2: Do the basic moles, mass, concentratin, solution volume conversions

The number of moles of solute in a bottle containing 225 mL of 0.220 mol/L sodium sulfite solution is

A. 0.0495 mol
B. 0.978 mol
C. 1.02 mol
D. 49.5 mol

The number of moles of sodium nitrate in a 40.0 mL sample of 0.150 mol/L is

A. 6.00×10^{0} mol
B. 2.67×10^{-1} mol
C. 3.75×10^{-3} mol
D. 6.00×10^{-3} mol

The molar concentration of a solution that contains 0.46 mol of solute in a volume of 200 mL is

A. 0.0023 mol/L
B. 0.092 mol/L
C. 2.3 mol/L
D. 92 mol/L

The concentration of 250 mL of solution that contains 0.0460 mol of sodium sulfate is

A. 0.0115 mol/L
B. 0.184 mol/L
C. 5.43 mol/L
D. 11.5 mol/L

78.0 g of silver sulfate is dissolved in water to make 500 mL of solution. The molar concentration of the resultant solution should be

A. 0.0500 mol/L
B. 0.125 mol/L
C. 0.500 mol/L
D. 0.764 mol/L

25.0 g of baking soda ($NaHCO_3$) are dissolved in enough water to make 200 mL of solution. The concentration of the solution is

A. 0.0596 mol/L
B. 0.125 mol/L
C. 0.671 mol/L
D. 1.49 mol/L

The concentration of a solution made by dissolving 11.7 g of sodium chloride in 500 mL of solution is

A. 0.100 mol/L
B. 0.200 mol/L
C. 0.400 mol/L
D. 0.800 mol/L

If 3.65 g of HCl is dissolved to make 200 mL of solution, the molar concentration is

A. 0.100 mol/L
B. 0.200 mol/L
C. 0.500 mol/L
D. 2.00 mol/L

The LEAST concentrated solution chosen from the following is

A. 200 mL of 1.00 mol/L $CH_3COOH_{(aq)}$
B. 150 mL of 0.500 mol/L $NaCl_{(aq)}$
C. 100 mL of 0.100 mol/L $CH_3OH_{(aq)}$
D. 50.0 mL of 0.150 mol/L $HNO_{3(aq)}$

The most concentrated solution is

A. 10.0 L of 0.500 mol/L solution of $NaBr_{(aq)}$
B. 0.100 mol $NaCl_{(s)}$ dissolved to make 50.0 mL of solution
C. 305 g of $C_{12}H_{22}O_{11(s)}$ is 1.00 L of solution
D. 50.0 g of $HCl_{(g)}$ dissolved to make 20.0 L of solution

T Use this data to answer the following question(s).

Solution I: 20 mL of 6.0 mol/L HCl
Solution II: 30 mL of 4.0 mol/L HCl
Solution III: 50 mL of 3.0 mol/L HCl
Solution IV: 100 mL of 1.0 mol/L HCl

T The solution of HCl that would react with the greatest mass of zinc is

A. I
B. II
C. III
D. IV

T The solution of HCl that would react most rapidly with zinc strip is most likely

A. I
B. II
C. III
D. IV

T The solutions that contain equal amounts of dissolved hydrogen chloride are

A. I and III
B. I and II
C. II and IV
D. III and IV

The mass of lithium fluoride contained in 100 mL of 2.00 mol/L solution is

A. 2.33 g
B. 5.19 g
C. 6.58 g
D. 7.71 g

The mass of sodium hydroxide needed to prepare 1.60 L of 0.100 mol/L solution is

A. 250 g
B. 6.40 g
C. 16.0 g
D. 640 g

The mass of calcium hydroxide necessary to make 40.0 mL of a 2.00×10^{-5} mol/L solution would be

A. 1.08×10^{-8} g
B. 4.57×10^{-5} g
C. 5.93×10^{-5} g
D. 5.93×10^{-2} g

A solution of sulfuric acid is labelled 6.00 mol/L. The number of grams of H_2SO_4 contained in 0.200 L of solution is

A. 3.27 g
B. 81.8 g
C. 118 g
D. 120 g

The mass of NaOH contained within a 10.0 mL sample of 0.002 50 mol/L $NaOH_{(aq)}$ solution is

A. 0.000 250 g
B. 0.001 00 g
C. 0.250 g
D. 1.00 g

The volume of 1.20 mol/L H_2SO_4 that will contain 0.300 mol of solute is

A. 0.125 L
B. 0.250 L
C. 0.360 L
D. 4.00 L

The volume of 6.00 mol/L HCl containing 1.50 mol of HCl is

A. 200 mL
B. 250 mL
C. 400 mL
D. 900 mL

The volume of 0.100 mol/L lead(II) nitrate solution that can be prepared using 66.2 g of the pure solid is

A. 500 mL
B. 2.09 L
C. 2.00 L
D. 2.46 L

In an experiment requiring the addition of a very small mass of sodium hydroxide to an aqueous solution, a chemist uses 5.00 mL of a standardized 3.00 mmol/L solution rather than obtaining the mass of a solid sample. The chemist measures the sodium hydroxide by solution volume rather than by mass of solid because

A. It was impossible to obtain the mass of the very small sample required.
B. Sodium hydroxide exists only in solution.
C. Volumetric methods are generally more convenient and accurate.
D. The sodium hydroxide was going to be dissolved eventually.

UNIT I - SOLUTIONS

Objective 3: Describe the procedure for preparing (and prepare) a solution of known concentration

A student was instructed to prepare 300 mL of a 0.800 mol/L solution of potassium dichromate. The correct procedure the student should follow is to dissolve

A. 155 g of solute in 300 mL of distilled water
B. 0.240 mol of solute in 300 mL of distilled water
C. 70.6 g of solute in 150 mL distilled water and then add water to a volume of 300 mL
D. 70.6 g of solute in 300 mL of distilled water

A student was given a bottle containing solid magnesium sulfate and asked to prepare 250 mL of a 0.200 mol/L magnesium sulfate solution. Which pieces of equipment listed below are necessary in order for the student to prepare the solution?

1. 100 mL beaker
2. 250 mL volumetric flask
3. scoopula
4. 10 mL pipet
5. funnel
6. centigram balance
7. 50 mL graduated cylinder
8. meniscus finder

A. 2, 3, 4, 6
B. 1, 2, 3, 5, 6, 8
C. 1, 2, 3, 5, 6
D. 1, 2, 4, 6, 7

A student was asked to prepare 100 mL of a 0.0500 mol/L sodium hydroxide solution. What step below is NOT necessary?

A. Calculate mass of solute required to prepare the solution.
B. Dry the volumetric flask in which the solution is to be prepared.
C. Dissolve the solid $NaOH$ in a volume of water less than is actually required.
D. Transfer the solution to a volumetric flask and bring the volume to the desired level.

UNIT I - SOLUTIONS

Objective 4: Dilute a solution to give a solution of known concentration and to do dilution calculations

The molar concentration of a solution made by diluting 10.0 mL of 0.740 mol/L $KCl_{(aq)}$ to 250 mL is

A. 0.0338 mol/L
B. 0.0296 mol/L
C. 0.0200 mol/L
D. 0.0185 mol/L

A student wishes to dilute a 250 mL sample of 6.00 mol/L $HCl_{(aq)}$ to 4.00 mol/L. The volume to which the solution should be diluted is

A. 9.6 mL
B. 167 mL
C. 375 mL
D. 500 mL

A student wishes to dilute some 6.00 mol/L $HCl_{(aq)}$ to make 5.00 L of 0.0100 mol/L HCl. The volume of 6.00 mol/L solution she should use is

A. 7.20 mL
B. 8.33 mL
C. 3.00 mL
D. 1.20 mL

In order to dilute 50.0 mL of 6.00 mol/L $HCl_{(aq)}$ to a concentration of 0.150 mol/L, water should be added until the final volume is

A. 1.25 L
B. 2.00 L
C. 2.50 L
D. 18.0 L

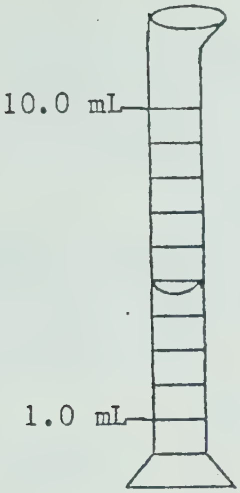
When a solution is diluted the

A. all of the below
B. mass of solute remains constant
C. number of moles of solute remains constant
D. concentration of the solution will decrease

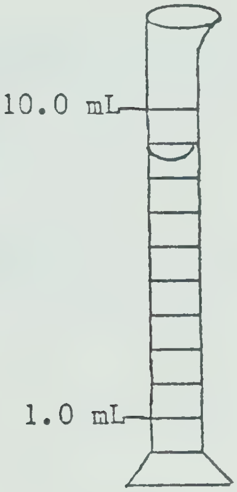
20.0 mL of 17.6 mol/L $HNO_{3(aq)}$ are diluted to 1.00 L. The concentration of the resulting solution is

A. 3.52 mol/L
B. 1.76 mol/L
C. 0.352 mol/L
D. 0.880 mol/L

Below are two 10 mL graduate cylinders containing sulfuric acid.



2.00 mol/L sulfuric acid



6.00 mol/L sulfuric acid

If the two solutions are poured together into a 100 mL beaker, the resulting concentration would be (Try to estimate the answer rather than doing any calculation.)

A. 0.59 mol/L
B. 4.0 mol/L
C. 4.7 mol/L
D. 10 mol/L

Which solution below will yield a 0.100 mol/L concentration when 100 mL of distilled water is added? (Assume the volumes are additive and make quick estimates for your answer.)

A. 50.0 mL of 0.300 mol/L KCl
B. 150 mL of 0.100 mol/L $Al(NO_3)_3$
C. 100 mL of 0.250 mol/L $NaNO_3$
D. 25.0 mL of 0.750 mol/L $CuSO_4$

100 mL of a 5.00 mol/L solution of ammonium phosphate is diluted to a 3.00 mol/L solution. The volume of water ADDED is approximately

A. 50 mL
B. 67 mL
C. 150 mL
D. 167 mL

UNIT I - SOLUTIONS

Objective 5: Define and use the terms electrolyte and nonelectrolyte and classify solutes as electrolytes and nonelectrolytes

A true statement pertaining to solutions is that

A. Electrolytic solutions are always saturated.
B. Nonelectrolytes always have a low solubility in water.
C. Solutions containing ions will conduct an electric current.
D. Solutions containing ions have an excess of either positive or negative ions.

Which of the following substances would be classified as a nonelectrolyte?

A. C_4H_9OH
B. $KMnO_4$
C. HCl
D. NaOH

Which of the substances below will form a nonconducting solution when dissolved in water?

A. $C_{12}H_{22}O_{11}$
B. $Ca(NO_3)_2$
C. KCl
D. $(NH_4)_3PO_4$

Which of the following substances is an example of an electrolyte?

A. $Br_2(l)$
C. $C_{25}H_{52}(s)$
C. $C_{12}H_{22}O_{11}(aq)$
D. $CuSO_4 \cdot 5H_2O(aq)$

Which of the following statements below is FALSE concerning electrolytic solutions?

A. They conduct electricity.
B. The overall charge in the solution is either positive or negative.
C. The solution is formed by dissolving an electrolyte in water.
D. The solution consists of ions dissolved in water.

UNIT I - SOLUTIONS

Objective 6: Write dissociation equations

The dissociation equation for dissolving $Al_2(SO_4)_3$ in water is

A. $Al_2(SO_4)_3(s) \longrightarrow 3Al^{3+}(aq) + 2SO_4^{2-}(aq)$
B. $Al_2(SO_4)_3(s) \longrightarrow Al^{3+}(aq) + SO_4^{2-}(aq)$
C. $Al_2(SO_4)_3(s) \longrightarrow 2Al^{3+}(aq) + 3SO_4^{2-}(aq)$
D. $Al_2(SO_4)_3(s) \longrightarrow 2Al^{2+}(aq) + 3SO_4^{3-}(aq)$

The correct equation for the dissociation of ferric sulfate is

A. $Fe_2(SO_4)_3(s) \longrightarrow Fe_2^{3+}(aq) + (SO_4)_3^{2-}(aq)$

B. $FeSO_4(s) \longrightarrow Fe^{2+}(aq) + SO_4^{2-}(aq)$
C. $Fe_2(SO_4)_3(s) \longrightarrow 2Fe^{2+}(aq) + 3SO_4^{2-}(aq)$
D. $Fe_2(SO_4)_3(s) \longrightarrow 2Fe^{3+}(aq) + 3SO_4^{2-}(aq)$

The correct equation showing the dissociation of strontium phosphate is

A. $SrPO_4(s) \longrightarrow Sr^{2+}(aq) + PO_4^{3-}(aq)$
B. $Sr_3(PO_4)_2(s) \longrightarrow 3Sr^{2+}(aq) + 2PO_4^{3-}(aq)$
C. $SrPO_4(s) \longrightarrow Sr^{2+}(aq) + PO_4^{3-}(aq)$
D. $Sr_3(PO_4)_2(s) \longrightarrow 3Sr^{3+}(aq) + 2PO_4^{2-}(aq)$

The equation that correctly shows the dissociation of lithium sulfate is

A. $LiSO_4(s) \longrightarrow Li^{2+}(aq) + SO_4^{2-}(aq)$
B. $Li_2SO_4(s) \longrightarrow 2Li^{1+}(aq) + SO_4^{2-}(aq)$
C. $Li_2SO_4(s) \longrightarrow Li_2^{2+}(aq) + S^{2-}(aq) + 4O^{2-}(aq)$
D. $Li_2SO_4(s) \longrightarrow 2Li^{+}(aq) + S^{2-}(aq) + 4O^{2-}(aq)$

UNIT I - SOLUTIONS

Objective 7: Do calculations involving the concentration of ionic species in solution

From the dissociation equation for $Al_2(SO_4)_3$, the student knows that the concentration of the alumium ions is how many times the concentration of the sulfate ions in a solution of this compound?

A. $\frac{3}{1}$ C. $\frac{2}{3}$

B. $\frac{3}{2}$ D. $\frac{1}{2}$

A student made a 0.20 mol/L solution of ammonium carbonate. The ratio of the concentration of NH_4^+ ions to CO_3^{2-} ions is

A. 1 : 1 C. 2 : 1
B. 1 : 2 D. 5 : 2

The concentration of hydroxide ions in 200 mL of 0.0010 mol/L calcium hydroxide solution is

A. 0.0010 mol/L C. 0.0040 mol/L
B. 0.0020 mol/L D. 0.0050 mol/L

A 0.25 mol/L solution of SrI_2 is totally dissociated into Sr^{2+} ions and I^- ions. The molar concentration of the iodide ions is

A. 0.13 mol/L C. 0.50 mol/L
B. 0.25 mol/L D. 0.75 mol/L

The concentration of nitrate ions in 100 mL of 1.00 mol/L zinc nitrate solution is

A. 2.00 mol/L C. 0.200 mol/L
B. 1.00 mol/L D. 0.100 mol/L

The molar concentration of the sulfate ions resulting from dissolving 17.1 g of aluminum sulfate in water to form 200 mL of solution is

A. 0.150 mol/L C. 0.695 mol/L
B. 0.250 mol/L D. 0.750 mol/L

A sample of ammonium carbonate was dissolved to make 500 mL of a solution. The ammonium ion concentration in this solution was found to be 0.100 mol/L. The mass of ammonium carbonate that must have been dissolved initially is

A. 4.81 g
B. 3.90 g
C. 2.40 g
D. 1.95 g

UNIT I - SOLUTIONS

Objective 8: Define and use the term solubility in a qualitative and quantitative sense

When solutions of barium nitrate and sodium chromate are mixed they form a precipitate. The chemical formula of the precipitate would be

A. $NaNO_{3(s)}$
B. $Na_2Ba_{(s)}$
C. $BaCrO_{4(s)}$
D. $CrO_4(NO_3)_{(s)}$

$CaCl_{2(aq)} + Cu_2SO_{4(aq)} \longrightarrow$

The products of the reaction above will be

A. $CaSO_{4(s)} + 2CuCl_{(s)}$
B. $CaSO_{4(aq)} + 2CuCl_{(s)}$
C. $CaSO_{4(s)} + 2CuCl_{(aq)}$
D. $CaSO_{4(aq)} + 2CuCl_{(aq)}$

The best definition of solubility is the

A. breaking up of a compound in solution into charged particles
B. molar concentration of a solution of a compound
C. ability of a solute to dissolve in different solvents
D. concentration of solute in a saturated solution

Which of the following substances would be soluble in water?

A. Ag_2SO_4
B. $Ba(OH)_2$
C. $CuCl$
D. $ZnCO_3$

Which of the following substances would have low solubility in water?

A. Rb_2SO_3
B. MgS
C. NH_4OH
D. $CaSO_4$

Which of the following substances will be soluble in water?

A. $BaSO_4$
B. HgI
C. $Fe(OH)_3$
D. SrS

From the four solvents given, the logical solvent to select to remove a grease spot from a garment is

A. $H_2O_{(l)}$
B. $HCl_{(aq)}$
C. $NaCl_{(aq)}$
D. $CCl_{4(l)}$

If silver dichromate (molar mass = 437.74 g) is dissolved in water to give 1.00 L of solution, then the LEAST amount of this substance that has to dissolve to consider the substance soluble is

A. 437.74 g
B. 43.77 g
C. 4.38 g
D. 0.44 g

UNIT I - SOLUTIONS

Objective 9: Do calculations relating to the quantitative definition of solubility

The concentration of an ammonium acetate solution is 19.2 mol/L. The mass of solid ammonium acetate that would remain if 100 mL of this ammonium acetate solution was evaporated to dryness is

A. 1.92 g
B. 2.49 g
C. 40.2 g
D. 148 g

The molar solubility of NaCl is 5.30 mol/L. The mass of NaCl that will dissolve in water to form 400 mL of saturated solution is

A. 23.4 g
B. 58.5 g
C. 124 g
D. 310 g

A saturated solution of hydroiodic acid contains 32.0 g of hydrogen iodide dissolved in 45 mL of solution. The molar solubility of hydroiodic acid is

A. 2.8 mol/L
B. 5.6 mol/L
C. 11 mol/L
D. 711 mol/L

If 44.0 g of cesium iodide dissolves to form 100 mL of saturated solution, the molar solubility of cesium iodide is

A. 1.69×10^{-1} mol/L
B. 1.14 mol/L
C. 1.69 mol/L
D. 440 mol/L

The molar solubility of $Fe(NO_3)_3 \cdot 6H_2O$ if 450 g of $Fe(NO_3)_3 \cdot 6H_2O$ dissolves to form 300 mL of saturated solution is

A. 7.00 mol/L
B. 4.30 mol/L
C. 2.59 mol/L
D. 1.29 mol/L

The molar solubility of KBr is 4.49 mol/L in cold water. The mass of $KBr_{(s)}$ that will REMAIN UNDISSOLVED in a beaker if 60.0 g of KBr are added to 100 mL of water in the beaker is

A. 6.6 g
B. 53.4 g
C. 59.0 g
D. 265 g

If 171 cm^3 of $CO_{2(g)}$ is dissolved in 100 mL of cold water, a saturated solution (0.076 mol/L) of $CO_{2(aq)}$ results. The mass of $CO_{2(g)}$ that would be dissolved in 500 mL of a saturated $CO_{2(aq)}$ solution is

A. 0.295 g
B. 1.67 g
C. 3.34 g
D. 3.88 g

UNIT I - SOLUTIONS

Objective 10: List the factors which affect solubility

The factor which does NOT affect the solubility of gases in water is

A. the pressure of the gas
B. the temperature of the water
C. the polarity of the gas molecules
D. the stirring rate

A quantity of sugar is added to a saturated sugar solution. The added sugar can be made to dissolve in the saturated solution by

A. rapid stirring
B. crushing the sugar
C. adding more water
D. increasing the pressure above the soltuion

Several srystals of blue colored $CuSO_4 \cdot 5H_2O_{(s)}$ are added to a saturated solution of copper (II) sulfate. The observation that will be made is

A. The blue color of the solution will intensify.
B. The blue color of the solution will fade.
C. There will be no change in the color intensity of the solution.
D. The color of the solution will change to a deep violet color.

Tetrachloroethene, C_2Cl_4, would be a good solvent for

A. CH_3OH
B. C_7H_{16}
C. K_2CO_3
D. NH_3

When a bottle of pop is opened, rapid bubbling appears. The reason for this is that the solubility of gases in liquids

A. increases with increasing temperature
B. decreases with decreasing gas pressure
C. increases with decreasing gas pressure
D. decreases with decreasing temperature

The factor that will have NO effect on solubility is the

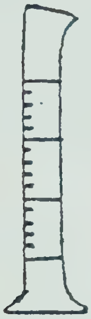
A. nature of the solute and solvent
B. temperature of the solvent
C. pressure on a gas
D. amount of stirring of a solution

UNIT I - SOLUTIONS

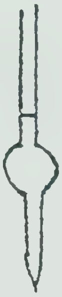
Objective 11: Demonstrate proficiency in the laboratory technique of pipetting.

The following diagram which represents a pipet is

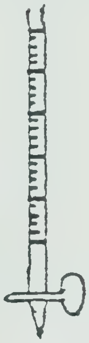
A.



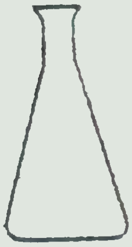
B.



C.



D.



The FALSE statement below about pipets is

A. Delivery pipets deliver a specific volume only.
B. Graduated pipets have a scale and measure incremental volumes.
C. When taking a sample of a liquid the pipet is first rinsed with distilled water.
D. The pipet is held between the fingers leaving the thumb free to seal the end of the pipet.

The correct procedure for using a pipet is

A. Always place the tip of the pipet close to the surface of the liquid.
B. Draw the liquid up the pipet using a bulb for suction.
C. When the liquid level reaches the top mark on the pipet, place the index finger over the end of the pipet.
D. Blow out the small amount of liquid remaining in the tip of a delivery pipet.

UNIT I - SOLUTIONS

Objecitve 12: List or identify four types of single replacement reactions in solution and two types of double replacement reactions in solution.

The products that could be produced when mossy zinc is placed in a solution of hydrochloric acid are

A. zinc hydride and chlorine gas
B. zinc chlorate and hydrogen gas
C. zinc chloride and water
D. zinc chloride and hydrogen gas

An example of a reaction in which a new metal would be formed is

A. chlorine gas + sodium iodide solution
B. hydrochloric acid + strontium hydroxide solution
C. iron metal + silver nitrate solution
D. potassium metal + water

When chlorine gas is bubbled through a solution of aqueous sodium bromide the formulas for the products formed are

A. NaBr and NaCl
B. NaCl and Br_2
C. Cl_2 and NaCl
D. NaBr and Cl_2

An example of a reaction in which hydrogen gas would be produced is

A. zinc metal + hydrochloric acid
B. sodium hydrogen sulfate solution + calcium nitrate solution
C. sulfuric acid + potassium hydroxide solution
D. chlorine gas + calcium iodide solution

An example of a reaction in which water and a salt would be formed is

A. $H_2SO_4(aq) + Na_3PO_4(aq) \longrightarrow$
B. $H_2CO_3(aq) + NH_4OH(aq) \longrightarrow$
C. $Zn_{(s)} + HCl_{(aq)} \longrightarrow$
D. $Na_{(s)} + HOH_{(l)} \longrightarrow$

When nitric acid is neutralized by rubidium hydroxide, the salt solution formed is

A. $RbNO_3(aq)$
B. $RbOH_{(aq)}$
C. $RbH_{(aq)}$
D. $HNO_3(aq)$

The reaction in which a precipitate will form is

A. $CsCl_{(aq)} + LiOH_{(aq)} \longrightarrow CsOH + LiCl$
B. $Rb_2SO_{4(aq)} + 2KOH_{(aq)} \longrightarrow 2RbOH + K_2SO_4$
C. $Al(CH_3COO)_{3(aq)} + 3NH_4NO_{3(aq)} \longrightarrow 3NH_4CH_3COO + Al(NO_3)_3$
D. $Ba(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \longrightarrow BaSO_4 + 2NaNO_3$

When ferric sulfate solution reacts with lithium hydroxide solution, the precipitate that forms is

A. $Fe_2(SO_4)_{3(s)}$
B. $Fe(OH)_{2(s)}$
C. $Li_2SO_{4(s)}$
D. $Fe(OH)_{3(s)}$

10.0 mL of lead(II) nitrate solution was mixed with 100 mL of 0.125 mol/L potassium iodate solution. A precipitate was formed. The correct formula for the precipitate is

A. $KNO_{3(s)}$
B. $Pb(IO_3)_{2(s)}$
C. $KI_{(s)}$
D. $Pb(NO_3)_{2(s)}$

When $FeSO_{4(aq)}$ solution reacts with H_2S gas, a precipitate forms. The formula of the precipitate is

A. $H_2SO_{4(s)}$
B. $FeS_{(s)}$
C. $FeH_{2(s)}$
D. $Fe_2(SO_4)_{3(s)}$

In order to precipitate all the cobalt(II) ions from 200 mL of 0.250 mol/L cobalt(II) nitrate, it was necessary to use 37.3 mL of potassium hydroxide. The cobalt(II) ions were removed by precipitation of

A. cobalt(II) hydroxide which could be collected by filtration
B. potassium nitrate leaving the cobalt(II) ions in the solution which could be evaporated
C. cobalt(II) hydroxide which couild be collected by evaporating the solvent
D. a complex unit consisting of cobalt(II) ions combined with potassium ions which was filtered off

[illegible]

[illegible] (aq) [illegible]

[illegible]) [illegible] + [illegible]

[illegible]] + [illegible]

[illegible] solution, the pre[illegible]

Fe[illegible](s)

Fe[illegible](s)

Li₂SO₄(s)

Fe(OH)₃(s)

10.0 mL of lead(II) [illegible]

0.125 mol/L [illegible]

concentration [illegible]

A. [illegible]

B. [illegible]

[illegible]

D. [illegible]

When Fe[illegible]

The formula [illegible]

[illegible](s)

B. FeS(s)

C. [illegible](s)

D. [illegible](s)

In order to precipitate [illegible]

0.1 mol/L [illegible]

potassium hydro[illegible]

precipitation

Li[illegible]

[illegible]

Barium chloride was mixed with a standard concentration of sodium sulfate. A white precipitate was formed. The ions remaining in the aqueous solution produced are

A. $2Na^{1+}(aq) + SO_4{}^{2-}(aq)$
B. $Na^{1+}(aq) + Cl^{1-}(aq)$
C. $Ba^{2+}(aq) + 2Cl^{1-}(aq)$
D. $Ba^{2+}(aq) + SO_4{}^{2-}(aq)$

UNIT I - SOLUTIONS

Objective 13: Write net ionic equations for the above reactions in solution.

Solutions of barium chloride and strontium sulfate are mixed. The net ionic equation for this reaction will be

A. $BaCl_2(aq) + SrSO_4(aq) \longrightarrow SrCl_2(aq) + BaSO_4(s)$
B. $Ba^{2+}(aq) + 2Cl^-(aq) + Sr^{2+}(aq) + SO_4{}^{2-}(aq) \longrightarrow$
$BaSO_4(s) + SrCl_2(s)$
C. $Sr^{2+}(aq) + 2Cl^-(aq) \longrightarrow SrCl_2(s)$
D. $Ba^{2+}(aq) + SO_4{}^{2-}(aq) \longrightarrow BaSO_4(s)$

The net ionic equation for the reaction between a sodium sulfide solution and a ferrous nitrate solution is

A. $Na_2S(aq) + Fe(NO_3)_2(aq) \longrightarrow FeS(s) + 2NaNO_3(aq)$
B. $2Na^+(aq) + S^{2-}(aq) + Fe^{2+}(aq) + 2NO_3{}^-(aq) \longrightarrow$
$Fe^{2+}(aq) + S^{2-}(aq) + 2Na^+(aq) + 2NO_3{}^-(aq)$
C. $Fe^{2+}(aq) + S^{2-}(aq) \longrightarrow FeS(s)$
D. $Fe^{2+}(aq) + SO_4{}^{2-}(aq) \longrightarrow FeSO_4(s)$

The net ionic equation for the reaction between a barium bromide solution and a sodium sulfate solution is

A. $BaBr_2(aq) + Na_2SO_4(aq) \longrightarrow 2NaBr(aq) + BaSO_4(s)$
B. $Ba^{2+}(aq) + 2Br^-(aq) + 2Na^+(aq) + SO_4{}^{-2}(aq) \longrightarrow$
$2Na^+(aq) + 2Br^-(aq) + Ba^{2+}(aq) + SO_4{}^{2-}(aq)$
C. $Ba^{2+}(aq) + 2Br^-(aq) + 2Na^+(aq) + SO_4{}^{2-}(aq) \longrightarrow$
$2Na^+(aq) + 2Br^-(aq) + BaSO_4(s)$
D. $Ba^{2+}(aq) + SO_4{}^{2-}(aq) \longrightarrow BaSO_4(s)$

The NET IONIC equation for the reaction between potassium metal and water is

A. $2K(s) + 2HOH(l) \longrightarrow H_2(g) + 2KOH(aq)$
B. $2K^+(aq) + 2HOH(l) \longrightarrow H_2(g) + 2K^+(aq) + 2OH^-(aq)$
C. $2K(s) + H_2O(l) \longrightarrow H_2(g) + K_2O(aq)$
D. $2K(s) + 2HOH(l) \longrightarrow H_2(g) + 2K^+(aq) + 2OH^-(aq)$

When cadmium is placed in a solution of silver nitrate a reaction takes place. The correct net ionic equation for this reaction is

A. $Cd_{(s)} + 2AgNO_{3(aq)} \longrightarrow Cd(NO_3)_{2(aq)} + 2Ag_{(s)}$
B. $Cd_{(s)} + 2AgNO_{3(aq)} \longrightarrow Cd^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2Ag_{(s)}$
C. $Cd_{(s)} + 2Ag^+_{(aq)} \longrightarrow Cd^{2+}_{(aq)} + 2Ag_{(s)}$
D. $Cd_{(s)} + 2NO_3^-{}_{(aq)} \longrightarrow Cd(NO_3)_{2(s)}$

When magnesium metal is placed in water a reaction occurs. The net ionic equation that would show this reaction is

A. $Mg_{(s)} + 2HOH_{(l)} \longrightarrow H_{2(g)} + Mg(OH)_{2(s)}$
B. $Mg_{(s)} + 2HOH_{(l)} \longrightarrow H_{2(g)} + Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$
C. $Mg_{(s)} + 2H^+_{(aq)} \longrightarrow H_{2(g)} + Mg^{2+}_{(aq)}$
D. $Mg_{(s)} + HOH_{(l)} \longrightarrow H_{2(g)} + MgO_{(s)}$

The correct NET IONIC equation which shows the reaction of chlorine gas added to a solution of sodium iodide is

A. $Cl_{2(g)} + 2I^-_{(aq)} \longrightarrow I_{2(aq)} + 2Cl^-_{(aq)}$
B. $Cl_{2(g)} + 2Na^+ \longrightarrow 2NaCl_{(aq)}$
C. $Cl_{2(g)} + 2NaI_{(aq)} \longrightarrow 2Cl^-_{(aq)} + 2Na_{(s)} + 2I^-_{(aq)}$
D. $Cl_{2(g)} + 2Na^+_{(aq)} + 2I^-_{(aq)} \longrightarrow 2Cl^-_{(aq)} + 2I^-_{(aq)} + 2Na^+_{(aq)}$

The NET IONIC equation for the reaction between lithium metal and nitric acid is

A. $2Li_{(s)} + 2HNO_{3(aq)} \longrightarrow H_{2(g)} + 2LiNO_{3(aq)}$
B. $2Li_{(s)} + 2H^+_{(aq)} + 2NO_3^-{}_{(aq)} \longrightarrow 2H^+_{(aq)} + 2Li^+_{(aq)} + 2NO_3^-{}_{(aq)}$
C. $2Li_{(s)} + 2H^+_{(aq)} + 2NO_3^-{}_{(aq)} \longrightarrow H_{2(g)} + 2Li^+_{(aq)}$ $2NO_3^-{}_{(aq)}$
D. $2Li_{(s)} + 2H^+_{(aq)} \longrightarrow H_{2(g)} + 2Li^+_{(aq)}$

The correct NET IONIC equation for the chemical reaction that takes place when calcium is placed in hydrobromic acid is

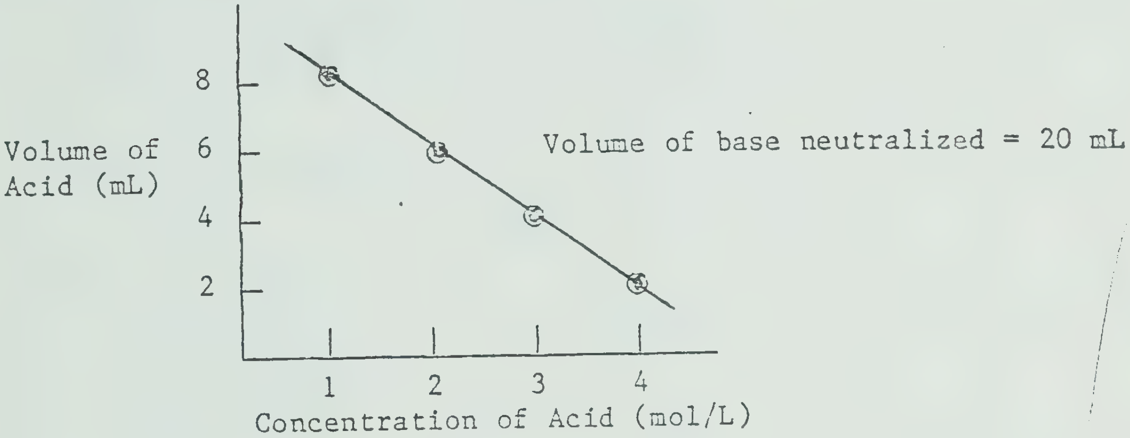
A. $Ca_{(s)} + 2HBr_{(aq)} \longrightarrow Ca^{2+}_{(aq)} + 2Br^-_{(aq)} + H_{2(g)}$
B. $Ca_{(s)} + 2H^+_{(aq)} \longrightarrow Ca^{2+}_{(aq)} + H_{2(g)}$
C. $Ca_{(s)} + 2HBr_{(aq)} \longrightarrow Ca^{2+}_{(aq)} + Br_{2(aq)} + H_{2(g)}$
D. $Ca_{(s)} + 2Br^-_{(aq)} \longrightarrow Ca^{2+}_{(aq)} + Br_{2(l)}$

UNIT I - SOLUTIONS

Objective 14: Do stoichiometric calculations relating to reactions in solution using nonionic equations.

D Use this information to answer the following question(s).

A student performs an experiment to determine if the volume of acid required to neutralize a given volume of base changes with the strength of the acid used. The results of his experiment are summarized below.



T From his results the student can infer that

A. As the acid concentration increases, the required volume of acid decreases.
B. As the acid concentration decreases, the required volume of acid decreases.
C. The acid concentration and required volume of acid are independent.
D. The volume of acid required is constant.

T* The general chemical equation to represent this type of reaction is

A. salt + base ⟶ acid + water
B. acid + water ⟶ salt + base
C. salt + acid ⟶ base + water
D. acid + base ⟶ salt + water

Copper(II) sulfide has a very low solubility, therefore it is precipitated completely. The mass of CuS that would be precipitated from 200 mL of a solution, where the concentrations of $Cu^{2+}_{(aq)}$ and $S^{2-}_{(aq)}$ are 0.800 mol/L, is

A. 0.160 g
B. 15.3 g
C. 19.2 g
D. 25.7 g

5T Use this information to answer the following question(s).
In a titration of sulfuric acid with sodium hydroxide to determine the concentration of the sodium hydroxide the following results were recorded.

Volume of H_2SO_4 used 10.0 mL
Concentration of H_2SO_4 used 2.00 mol/L

Trial	1	2	3
Final buret reading (mL)	25.2	48.9	23.9
Initial buret reading (mL)	1.7	25.2	0.6
Volume of base added (mL)	23.5	23.7	23.3

6T To calculate the concentration of the sodium hydroxide solution, the student must first calculate the

C
A. number of moles of sodium hydroxide used
B. mass of sulfuric acid used
C. number of moles of sulfuric acid used
D. mass of sodium hydroxide used

7T If the equation for the reaction that takes place is written as
$\_\_NaOH_{(aq)} + \_\_H_2SO_4(aq) \longrightarrow \_\_Na_2SO_4(aq) + \_\_HOH(l)$
the coefficients for the balanced equation are respectively

0
A. 2, 1, 2, 1
B. 2, 1, 1, 2
C. 1, 2, 2, 1
D. 1, 2, 1, 2

8T The concentration of the sodium hydroxide was

0
A. 1.55 mol/L
B. 1.70 mol/L
C. 2.00 mol/L
D. 4.00 mol/L

T Use this information to answer the following question(s).

$AsCl_{3(aq)} + 3NaOH_{(aq)} \longrightarrow As(OH)_{3(s)} + 3NaCl_{(aq)}$

25.0 mL of arsenic(III) chloride solution is reacted with an excess of 0.200 mol/L NaOH, forming 3.15 g of solid precipitate.

0T The number of moles of $As(OH)_{3(s)}$ that formed is

A. 0.150 mol
B. 0.0150 mol
C. 0.0250 mol
D. 0.350 mol

1T The number of moles of NaOH that reacted is

A. 0.150 mol
B. 0.0450 mol
C. 0.0750 mol
D. 0.200 mol

2T The concentration of the original $AsCl_{3(aq)}$ solution is

A. 1.00 mol/L
B. 1.33 mol/L
C. 1.50 mol/L
D. 0.0250 mol/L

3T The minimum volume of 0.200 mol/L $NaOH_{(aq)}$ that would be required to react completely with 25.0 mL of the $AsCl_{3(aq)}$ solution used in this experiment is

3

A. 325 mL
B. 375 mL
C. 450 mL
D. 560 mL

---

14 The volume of 0.25 mol/L $KCl_{(aq)}$ solution required to precipitate completely the silver ions as $AgCl_{(s)}$ from a 60 mL sample of 0.60 mol/L $AgNO_{3(aq)}$ solution is

7

A. 0.0069 L
B. 0.36 L
C. 0.14 L
D. 0.25 L

15 The volume of 0.420 mol/L hydrochloric acid which could be neutralized with 8.40 g of solid sodium hydroxide is

6

A. 600 mL
B. 500 mL
C. 400 mL
D. 50.0 mL

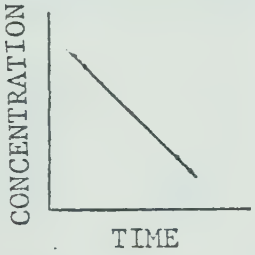
T Use this information to answer the following question(s).

A student reacts solid zinc with several copper(II) sulfate solutions of different concentrations to produce metallic copper. The student recorded the time required to produce 1.0 g of copper and recorded the concentration of the copper(II) sulfate solutions.

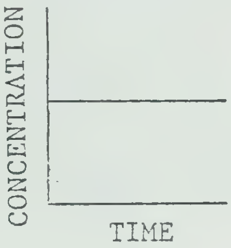
Concentration of copper(II) sulfate solution (mol/L)	Time required to produce 1.0 g of copper (min)
1.0	50
2.0	40
3.0	45
4.0	20
5.0	10

7DT If the student drew a graph of the results it would look like

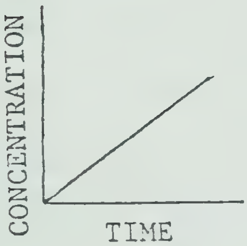
A.



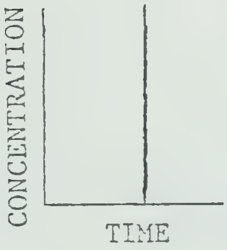
C.



B.



D.



8T From his observations, the student would infer that the time required to produce 1.0 g of copper depends on

A. mass of zinc used
B. time allowed for this reaction
C. concentration of copper(II) sulfate
D. the size of the reaction vessel

9 The volume of 0.100 mol/L potassium iodide which would have the same number of moles of potassium iodide as there are moles of $Cu(NO_3)_2$ in 25.0 mL of 0.100 mol/L $Cu(NO_3)_2(aq)$ is

A. 12.5 mL
B. 62.5 mL
C. 50.0 mL
D. 25.0 mL

20T Use this information to answer the following question(s).

A student reacted 10.0 mL of $Pb(NO_3)_{2(aq)}$ with 100 mL of 0.220 mol/L $KIO_{3(aq)}$. 1.39 g of white precipitate was produced.

21T The quantity of lead(II) iodate produced was

9 A. 1.39 mmol C. 2.74 mmol
B. 2.50 mmol D. 5.00 mmol

22T The molar concentration of the original lead(II) nitrate solution was

6 A. 0.150 mol/L C. 0.250 mol/L
B. 0.200 mol/L D. 0.300 mol/L

---

23 The volume of 0.100 mol/L sulfuric acid required to neutralize 50.0 mL of 0.250 mol/L lithium hydroxide would be

A. 62.5 mL C. 125 mL
B. 100 mL D. 250 mL

24 If a certain mass of Cu completely reacted with 0.350 L of 0.750 mol/L $AgNO_3$ solution, the mass of silver produced is

A. 56.8 g C. 27.3 g
B. 28.3 g D. 26.3 g

25* Use this information to answer the following question.

A student reacts solid zinc with several copper(II) sulfate solutions of different concentrations to produce metallic copper. The student recorded the time required to produce 1.0 g of copper and recorded the concentration of the copper(II) sulfate solutions.

Concentration of copper(II) sulfate solution (mol/L)	Time required to produce 1.0 g of copper (min)
1.0	50
2.0	40
3.0	45
4.0	20
5.0	10

The balanced equation for the reaction is

98 A. $CuSO_4(aq) + Zn_2(s) \longrightarrow ZnSO_4(aq) + Cu(s)$
B. $Cu_2SO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + 2Cu(s)$
C. $Cu_2SO_4(aq) + 2Zn(s) \longrightarrow Zn_2SO_4(aq) + 2Cu(s)$
D. $CuSO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + Cu(s)$

26 When an excess of potassium iodide is added to an acidic solution of copper(II) ions, the following reaction occurs.

$$5I^-_{(aq)} + 2Cu^{2+}_{(aq)} \longrightarrow 2CuI_{(s)} + I_3^-{}_{(aq)}$$

After the reaction was completed the concentration of the $I_3^-{}_{(aq)}$ was 0.470 mol/L. The volume of resulting solution was 125 mL. The mass of $CuI_{(s)}$ formed was

0
A. 0.118 g
B. 5.88 g
C. 11.2 g
D. 22.5 g

27 The final mass of a 1.09 kg Zn bar assuming complete reaction with 2.50 L of a 6.00 mol/L $HCl_{(aq)}$ would be about

A. 0.11 kg
B. 0.49 kg
C. 0.60 kg
D. 0.98 kg

28T Use this data to answer the following question(s).

A student reacted a 20.0 mL sample of barium chloride solution with an excess of 0.200 mol/L $H_2SO_{4(aq)}$. A precipitate formed which, when filtered and dried, had a mass of 2.34 g.

29T* The formula for the precipitate formed in this reaction was

9
A. $BaH_{2(s)}$
B. $BaSO_{4(s)}$
C. $BaCl_{2(s)}$
D. $HCl_{(s)}$

30T The number of mmoles of barium chloride in the original sample was

6
A. 5.00 mmol
B. 8.00 mmol
C. 10.0 mmol
D. 20.0 mmol

---

31 The volume of 0.0500 mol/L $NaOH_{(aq)}$ solution required to neutralize 10.0 mL of 0.150 mol/L $H_2CO_{3(aq)}$ solution is

0
A. 60.0 mL
B. 45.5 mL
C. 30.0 mL
D. 15.0 mL

32T Use this information to answer the following question(s).

Element A will react with ions of Element B in solution (similar to Zn reacting in a $CuSO_4$ solution). A strip of A was placed in 100 mL of solution containing B ions. The data collected in the laboratory were

Mass of A before reacting	37.2 g
Mass of A after reacting	36.0 g.
Mass of dry B formed	6.0 g
Molar mass of A	20.0 g/mol
Molar mass of B	50.0 g/mol

33T From the data the ratio of the moles of A that reacted to the moles of B formed is

0 A. 1 : 1 C. 2 : 1
B. 1 : 2 D. 2 : 5

34T If the ions of A have a charge of 2+, then the charge of the B ions is

0 A. 2- C. 1+
B. 1- D. 2+

35T The concentration of the aqueous B ions in the original solution was

0 A. 0.12 mol/L C. 1.2 mol/L
B. 0.50 mol/L D. 12 mol/L

36T After the reaction goes to completion the concentration of the $A^{2+}{}_{(aq)}$ is

0 A. 0.060 mol/L C. 1.8 mol/L
B. 0.60 mol/L D. 18 mol/L

---

37 A 0.0100 L sample of 18.0 mol/L $H_2SO_{4(aq)}$ is mixed with enough distilled water to make 1.00 L. If 10.0 mL of this solution is needed to neutralize 0.0300 L of $NaOH_{(aq)}$, then the concentration of the base would be

6 A. 0.180 mol/L C. 0.360 mol/L
B. 0.120 mol/L D. 1.20 mol/L

38 10.0 mL of a soda pop was titrated to endpoint using 0.0100 mol/L $KOH_{(aq)}$ solution.

Final buret reading	15.2 mL
Initial buret reading	9.0 mL

The concentration of carbonic acid in the soda pop sample is

A. 3.1 mmol/L C. 7.6 mmol/L
B. 6.2 mmol/L D. 8.1 mmol/L

.39 If 20.0 mL of 0.400 mol/L $HCl_{(aq)}$ solution reacts with 30.0 mL of $Ba(OH)_{2(aq)}$ solution, the concentration of the base solution is

A. 0.133 mol/L C. 0.533 mol/L
B. 0.267 mol/L D. 0.667 mol/L

40 10.0 mL of $KOH_{(aq)}$ is added to 40.0 mL of distilled water. This 50.0 mL mixture is titrated to enpoint using 10.0 mL of 0.500 mol/L $HCl_{(aq)}$ solution. The concentration of the titrated (diluted) $KOH_{(aq)}$ solution is

3 A. 0.100 mol/L C. 0.500 mol/L
B. 0.250 mol/L D. 2.50 mol/L

41T Use this data to answer the following question(s).
A 0.200 mol/L potassium hydroxide solution in a buret is titrated into a 100.0 mL sample of carbonic acid in an Erlenmeyer flask.

Final buret reading	42.6 mL
Initial buret reading	3.4 mL

42T* The number of moles of base that were reacted in this experiment is

6 A. 6.47 mmol C. 8.95 mmol
B. 7.84 mmol D. 12.0 mmol

43T The number of moles of carbonic acid that were reacted in this experiment was

9 A. 3.24 mmol C. 3.92 mmol
B. 3.46 mmol D. 6.00 mmol

44T The concentration of the carbonic acid sample was

7 A. 39.2 mmol/L C. 60.0 mmol/L
B. 89.5 mmol/L D. 32.4 mmol/L

45 The mass of copper metal required to react completely with 600 mL of 0.200 mol/L $AgNO_3$ solution is

A. 1.91 g C. 7.62 g
B. 3.81 g D. 10.2 g

46 The volume of 0.250 mol/L $H_2SO_{4(aq)}$ needed to neutralize 100 mL of 0.250 mol/L $KOH_{(aq)}$ would be

15 A. 25.0 mL C. 100 mL
B. 50.0 mL D. 200 mL

47T The minimum volume of 0.220 mol/L $KIO_{3(aq)}$ necessary to completely react with the original $Pb(NO_3)_{2(aq)}$ was

00 A. 100 mL C. 34.6 mL
B. 58.2 mL D. 22.7 mL

8 Use this information to answer the following question.

A student reacted 10.0 mL of $Pb(NO_3)_{2(aq)}$ with 100 mL of 0.220 mol/L $KIO_{3(aq)}$. 1.39 g of white precipitate was produced.

After the reaction was completed, the quantity of KIO_3 in excess in this experiment was

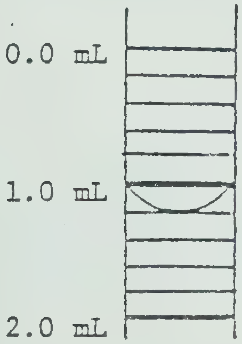
A. 17.0 mmol
B. 23.0 mmol
C. 28.0 mmol
D. 50.0 mmol

9 A 10.0 L sample of river water was found to contain aqueous iron(III) ions. It was also found that 3.00 g of $NaOH_{(s)}$ caused all the iron(III) ions to precipitate out of solution as iron(III) hydroxide. The concentration of iron(III) ions in the river water sample was

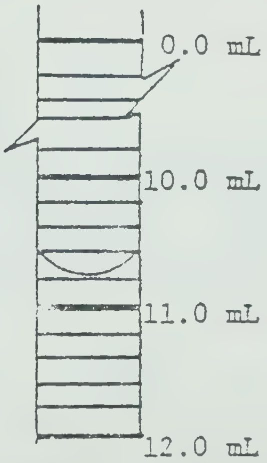
3 A. 2.50 mmol/L
B. 7.50 mmol/L
C. 25.0 mmol/L
D. 75.0 mmol/L

0TD Use this information to answer the following question(s).

A chemist analyzed a sample of tap water from a Canadian home to determine the purity of the water supply. He finds that the sample contains dissolved iron(III) nitrate. To complete his analysis he must determine the concentration of the iron(III) ion. He does so by titrating 400 mL of the water with 0.0400 mol/L sodium hydroxide.



Initial reading of $NaOH_{(aq)}$



Final reading of $NaOH_{(aq)}$

1T The volume of sodium hydroxide used was

1 A. 1.2 mL
B. 8.6 mL
C. 9.6 mL
D. 10.8 mL

2T The number of moles of iron(III) nitrate in the water sample was

0 A. 0.13 mmol
B. 0.32 mmol
C. 0.38 mmol
D. 16 mmol

53T The concentration of iron(III) nitrate was

0 A. 0.29 mmol/L
B. 0.32 mmol/L
C. 0.80 mmol/L
D. 0.96 mmol/L

54T The dissociation equation for the iron(III) nitrate is

32 A. $Fe(NO_3)_{3(s)} \longrightarrow Fe^{+}_{(aq)} + 3NO_3^{-}{}_{(aq)}$
B. $Fe(NO_3)_{3(s)} \longrightarrow Fe^{3+}_{(aq)} + NO_3^{-}{}_{(aq)}$
C. $Fe(NO_3)_{3(s)} \longrightarrow Fe^{3+}_{(aq)} + 3NO_3^{-}{}_{(aq)}$
D. $Fe(NO_3)_{3(s)} \longrightarrow 3Fe^{3+}_{(aq)} + NO_3^{-}{}_{(aq)}$

.55T The concentration of the iron(III) ion is

71 A. the same as the concentration of $Fe(NO_3)_{3(aq)}$
B. three times the concentration of $NO_3^{-}{}_{(aq)}$
C. the same as the concentration of $NaOH_{(aq)}$
D. the same as the concentration of $NO_3^{-}{}_{(aq)}$

.56 A 9.0 g piece of alumium metal is put into 200 mL of 0.40 mol/L hydrochloric acid solution and left for complete reaction, then the mass is redetermined. The final mass should be close to

A. 0.73 g
B. 2.2 g
C. 6.8 g
D. 8.3 g

.57 A 10.0 mL sample of vinegar was added to 55.0 mL of distilled water and then titrated to endpoint using 0.0500 mol/L $NaOH_{(aq)}$.

Final buret reading of $NaOH_{(aq)}$ solution	14.0 mL
Initial buret reading of $NaOH_{(aq)}$ solution	7.2 mL

The concentration of the acetic acid in the original vinegar sample is

51 A. 3.4×10^{-4} mol/L
B. 6.8×10^{-3} mol/L
C. 3.4×10^{-2} mol/L
D. 5.0×10^{-2} mol/L

UNIT I - SOLUTIONS

Objective 15: Do stiochiometric calculations relating to reactions in solution using net ionic equations.

1T Use this data for the following question(s).

To eliminate calcium ions from 200 mL of solution, 500 mL of sodium hydroxide solution is added. After a reaction, 7.41 g of precipitate is formed.

2T The concentration of hydroxide ion in the 500 mL of sodium hydroxide solution was

A. 0.0280 mol/L
B. 0.0500 mol/L
C. 0.400 mol/L
D. 1.00 mol/L

3T The concentration of the calcium ion in the original solution is

A. 0.0250 mol/L
B. 0.0500 mol/L
C. 0.500 mol/L
D. 1.00 mol/L

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4 A solution is known to contain $S^{2-}_{(aq)}$ ions. If 200 mL of the solution was found to react with 60.0 mL of 0.200 mol/L lead(II) nitrate solution, the concentration of the $S^{2-}_{(aq)}$ ions in the solution is

3 A. 0.00300 mol/L
B. 0.0120 mol/L
C. 0.0600 mol/L
D. 1.80 mol/L

.5 Solutions of $Ba(NO_3)_2$ and K_2CrO_4 are mixed and 2.53 g of a precipitate are formed. If 200 mL of each solution was used, the concentration of the potassium ions in the original solution of K_2CrO_4 is

A. 0.20 mol/L
B. 0.50 mol/L
C. 0.10 mol/L
D. 0.125 mol/L

.6 A student was asked to determine the hydrogen ion concentration of a strong acid solution. 400 mL of the acid reacted with 2.616 g of zinc. The concentration of hydrogen ions in the unknown acid is

A. 0.200 mol/L
B. 0.100 mol/L
C. 0.0500 mol/L
D. 0.0320 mol/L

.7 3.27 g of zinc metal reacted with exactly 400 mL of a strong acid solution. The concentration of the hydrogen ions in the acid solution was

90 A. 0.100 mol/L
B. 0.125 mol/L
C. 0.250 mol/L
D. 0.375 mol/L

A student placed a strip of copper metal in 400 mL of silver nitrate solution. The copper had an initial mass of 76.50 g and a final mass of 70.14 g. The concentration of the silver ions in the solution is

A.	0.100 mol/L	C.	0.250 mol/L
B.	0.200 mol/L	D.	0.500 mol/L

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